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ABSTRACT

This packet of resource materials contains four sections: curriculum activities, a career guide for women, a role models list, and an annotated bibliography. These materials deal with women in science and mathematics and cover primary through high school educational levels. Skill Activities are outlined for use at various (K-12) levels which were designed to aid the development of scientific and mathematical skills and show the relevance of these to technical jobs. The Career Guide describes careers in selected areas of mathematics and science. The Role Models section provides information about the accomplishments of women in the sciences, including Nobel Prize winners, prominent black women scientists, inventors, and prominent scientists in each of the major science areas. An annotated list of materials, including juvenile fiction and nonprint media, that introduce scientific topics, female role models, and biographies of women scientists, is also provided. (CS)

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HOW HIGH THE SKY? HOW FAR THE MOON?

WOMEN SCIENTISTS TODAY

An Educational Program for Girls and Women in Math and Science, Lafayette, Colorado

SHARON L. MENARD

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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WOMEN SCIENTISTS TODAY

"Being able to unravel a small aspect of the marvels of the universe..."

Sonia Gitlin, Chemist

"Girls need to think of a career-directed education. They must overcome the negative image of science and scientists."

Dr. Agnes Stroud Schmink,
Radiation Biologist

"It is especially exciting when an experiment you have designed works."

Diane Dieter, Research Technician

"In my opinion, the more women in the field the better it will be for men, women, and science."

Today's women scientists share a heritage with the great women scientists who were their predecessors. Their work is exciting. They display courage and persistence as did scientists in the past. They encourage girls to consider working in the scientific fields, but they express a word of caution: it is not all glamour. It is hard, often tedious work. They admit that it is difficult to compete in a man's world and to combine career and family, but none would do otherwise if the choice were theirs to make again.

In the next few pages, you will meet some of today's women scientists. They are a small sample of the women who have chosen one of the sciences as their profession.

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Dr. Margaret Ackerman, Chemist

Director of Metabolism and Radio Chemistry
Rhoads Scientific Company, Colorado Springs, Colorado

"I care about clean air and clean water. My work can help solve some of our environmental problems," according to Dr. Margaret Ackerman. She specializes in the chemical analysis of substances which are subject to Federal health and environmental regulations. She feels her work can make the difference in the air we breathe and the water we drink.

When she was a young girl, Dr. Ackerman thought she might be a medical doctor, but, later in college, an undergraduate chemistry professor offered an opportunity to do independent research and encouraged her to continue on in chemistry. She considers this fortunate because, as she reflects on this, she realizes that she is temperamentally unsuited for medicine and for dealing with death.

Dr. Ackerman's inclinations for science, particularly research, were very strong by the time she began high school. She attributes this to her aunt, a mathematics teacher. Dr. Ackerman admiringly describes a remarkable woman who was a strong influence on her and provided a role model. This aunt, who raised her after her mother died, encouraged her interest in science and taught her to value her freedom to be anything she wanted to be.

When Dr. Ackerman completed her bachelor's degree in chemistry, she continued into graduate school where she met her future husband, one of her students in the chemistry laboratory course which she taught. She married her student, quit her graduate studies, and took a job to help him finish his education in nuclear engineering. Her jobs included chemistry analysis work with Shell Oil Company and Lawrence Berkeley Laboratory in California.

Nine years later, when her marriage ended, she returned to New Mexico and continued her interrupted graduate studies, receiving her Ph.D. degree in 1971.

Dr. Ackerman is an active, busy person whose life is not restricted to her job. Besides her work, which she finds very satisfying, she is actively involved in politics and sports — tennis, skiing, and hiking. When she isn't on the go, she says, "I read everything."

EDUCATION: B.S. Chemistry, 1957, University of New Mexico
Ph.D. Chemistry, 1971, University of New Mexico

Diane Dieter, Biologist

Research Technician, Cancer and Transplantation Immunology
AMC Cancer Research Center and Hospital, Lakewood, Colorado

"I'm in charge of our mouse colony at AMC," says Diane Dieter. This includes genetic selection, inbreeding, and weaning. The mice are used in the research work at her laboratory. She points out that her laboratory is small and therefore "we do all the work, from dishwashing to ordering supplies to planning and executing the experiments."

When Ms. Dieter was a young girl, she thought she would be a housewife, but her mother always said she should be a veterinarian. From junior high school on, states Ms. Dieter, "science was my area." Although she liked her science classes, she had many other interests, including active participation on stage crews and in stage management. At one point in college, her avocational activities became so pervasive that her card-playing hobby "almost resulted in her majoring in bridge."

After she received her B.S. degree, she moved to Madison, Wisconsin and the University of Wisconsin for graduate work in genetics and molecular biology, but she quit after three semesters. She was uncertain about this field of study and felt that she was not ready for the pressures of graduate school. It was then that she returned to her native Denver where job-hunting was tough. It took six months to find her current job.

For Ms. Dieter, research is exciting and intellectually stimulating, although, she points out, "it is not as romantic as I originally envisioned." Besides the intellectual challenge, she feels her work allows considerable freedom to schedule her hours and to be creative and innovative.

When she was 18, she almost married, but decided not to do it. As she describes it, "It was the first step towards learning to love myself and learning, if I didn't, there was nothing to give anyone else." In addition she thinks it is important for every person to be able to financially support him- or herself. She emphasizes: having a career, not just a job, can make working for a living very interesting."

Today, although her family lives in the same city, she has her own apartment, which she shares with two "dependents" — her two cats — whom she describes as "alley variety". And once again, she is contemplating marriage to a man who does research in the same laboratory.

EDUCATION: B.S., 1972, Willamette University, Salem, Oregon
Graduate work in Genetic and Molecular Biology, University of Wisconsin
Graduate work in Biology, University of Colorado

Sonia Navia Gitlin, Chemist

Support Scientist, National Center for Atmospheric Research, Boulder, Colorado

A Swedish mother who was an actress and a Spanish father who was a businessman are part of the international heritage of Sonia Navia Gitlin, who grew up in Argentina. This heritage is the reason that Ms. Gitlin loves literature and music and speaks several languages. Her father died when she was eight years old, leaving her mother to raise her and her brother alone and there was not enough money to provide for college educations. Therefore, although Ms. Gitlin had an early interest in science, she did not expect to go to college. Instead, she took a secretarial position which allowed her to use her language translation skills.

When she was in her early thirties, a prolonged illness gave her time to rethink her future. Science was still high on her list, so she decided to attend college and study chemistry. The lure of the American West proved irresistible and she was accepted at the University of Colorado. It was while there, in her sophomore year, that Ms. Gitlin met and married her husband. That was 23 years ago. They are still married today and their two boys have grown and gone away to college.

Ms. Gitlin's college training was very important to her, so that, despite having a family, she continued into graduate school, juggling her studies with the care of her then young children. She says, "It is not easy to have two full-time roles: career woman and homemaker and mother. Although my husband supports my view in theory, it does not always work so well in practice." But, she would not have it otherwise because, as she points out, "It gives me a chance to fulfill my intellectual needs."

After she received her masters degree, she thought of going on for a Ph.D. degree, but further family responsibilities, including her mother's illness, prevented her from doing so. When the demands of her family lessened, she took a job with a National Center for Atmospheric Research, where she has been for the past sixteen years.

EDUCATION: B.S. Chemistry, 1959, University of Colorado at Boulder
M.A. Physical Chemistry, 1966, University of Colorado at Boulder

Dr. Margaret (Peggy) LeMone, Atmospheric Scientist

Ph.D. Scientist
National Center for Atmospheric Research, Boulder, Colorado

When Dr. LeMone, the youngest of four children (three brothers), was a young girl, she dreamed of being many things. In first grade, she was a nurse. In second grade, she was a firefighter. But, by the time she entered seventh grade, she became a meteorologist,since her interest in weather forecasting had already developed. In fact, she thought her native Missouri was so interesting that she kept weather records; the earliest ones consisted of drawings of clouds. She liked to draw then, and she still does today. Her hobbies include sketching and cartooning.

Her interest in weather received further encouragement from several directions, starting with a fifth grade teacher who told her that she had a very exciting future, and a meteorologist in the local weather bureau. She also was encouraged by her older brother, Charlie. After Dr. LeMone's father died, her mother worked outside of the home and her older brother became a parent in residence. He shared her interest in science and treated her "as if she were some kind of a genius." She also learned something else in that part of her life — the need to have a vocation and to be able to earn one's own living.

During Dr. LeMone's early school years, although she liked her art and physical education courses, her interest in science advanced as her mathematics and physics courses advanced. Therefore, after high school, she chose to study mathematics. She points out, though, that the amount of mathematics and science which she studied is not necessary for all phases of meteorological work. It was her personal preference, particularly since she aspired to the research aspects of meteorology. In graduate school she majored in Atmospheric Sciences.

In 1972 Dr. LeMone began working for the National Center for Atmospheric Research, a research laboratory that specializes in her line of work. She finds her work challenging and varied. She describes the "glamour" part,which includes travel and meeting people from all over the world, but she also describes the other challenging, yet frustrating, part,which includes taking the results of her experiments and data collection and analyzing these to learn what is really happening in the atmosphere. It is the latter which requires patience, persistence, and painstaking attention to detail and accuracy, which are important requirements for all scientific work.

Two years ago, Dr. LeMone married a fellow scientist whom she met at her laboratory. They are looking forward to their first child in 1979 when Dr. LeMone expects to combine parenting, another challenging career, with her science. She thinks that she will continue to work part time because she feels that complete absence, over an extended period of time, will make it difficult for her to keep in touch with her profession.

EDUCATION: A.B. Mathematics, 1967, University of Missouri-Columbia
Ph.D. Atmospheric Sciences, 1972, University of Washington, Seattle

Georgia Pedro, Environmental Engineer

District Sanitarian
U.S. Public Health Service, Santa Fe, New Mexico

Her high school counselor told her that she would never make it through engineering school. While she was in engineering school, another counselor told her that she would never graduate. She did not have enough high school mathematics. With all this discouragement, it is surprising she did graduate from engineering school. But it was what she wanted, and perhaps these counselors did not count on Georgia Pedro's persistence and determination. She was the first to enter and graduate from the New Mexico Institute of Technology's new field of environmental engineering.

A few years later she was invited to speak about her work at that same college to visiting high school students. Her only disappointment was not seeing that counselor. She wanted to let him know that she had "made it".

When Ms. Pedro, the oldest child in her family, was a little girl living at the Laguna Indian Pueblo in New Mexico, she waited with anticipation, for her grandfather's return from his field work. He worked in the geology department of the Anaconda Company and he always brought "such interesting things" back with him — rocks, fossils, etc. Her grandfather's influence and her liking for mathematics contributed to Ms. Pedro's desire to try engineering. She wasn't certain what kind and she didn't know much about it, but it seemed right to her.

Today, Ms. Pedro is a commissioned officer in the U.S. Health Service, working as District Sanitarian in the Indian Health Service in New Mexico. She travels throughout her district, providing assistance to 14 Indian tribes. Her job includes supervision of other environmental health personnel, including field sanitarians and environmental health technicians. She works mainly in rural areas, doing, for example, health and sanitation inspections, planning water and sewer systems for the reservations, orienting public health nurses, conducting rabies clinics, and other duties related to environmental health.

Ms. Pedro grew up at the Laguna Pueblo. Five years ago, she married her husband, Vincenti, who came from the same Indian reservation. They went to high school there together. They have a five year old daughter. As Ms. Pedro puts it, "I got my MRS, MPH, and MOM all in the same year."

EDUCATION: B.S. Environmental Engineering, 1970, New Mexico Institute of Technology
MPH Environmental Health Sciences, 1973, University of California-Berkeley

Dr. Agnes Stroud Schmink, Radiation Biologist

Senior Staff Member, Los Alamos Scientific Laboratory
Los Alamos, New Mexico

"This teacher in seventh grade did something with test tubes. I'm not sure what, but I remember that it was fascinating." Agnes Stroud Schmink wanted to do that too. "My older sisters encouraged me to follow in their footsteps and learn typing, but I didn't care for it. I really wanted to know what made things work."

Dr. Stroud grew up in New Mexico, where her parents were both teachers at the Indian School in Albuquerque. Her father was an American Indian from the Tewa Tribe, Santa Clara Pueblo. She was the fourth of five children. Her parents always taught them to seek higher education or training for a career so that going to college was a natural choice.

While Dr. Stroud was in college, she almost started a career other than the one she planned in biology. Jacqueline Cochrane, the famed woman pilot, started a pilot training school in New Mexico to prepare women for the World War II war effort. Pilots were needed to taxi airplanes into the war zone in England. Dr. Stroud trained at that school, but the war ended before she completed her training and she never used her pilot certificate in the war effort.

After college graduation, Dr. Stroud began working at Los Alamos Scientific Laboratory. She tested blood from people working at the laboratory to check for possible radiation effects. One of those people was Enrico Fermi, the famous nuclear physicist who won the Nobel Prize for his work. He encouraged her to come to the University of Chicago where he taught and to continue her scientific training. Thus, she began the 21-year period of her life which ultimately lead to her Ph.D. degree in biological sciences and to her expertise in the field of radiation biology. A radiation biologist studies the effects of radiation on living cells.

In addition to graduate school, Dr. Stroud worked at Argonne National Laboratory, where she met her first husband, a biomathematician. Within a few short years after their marriage, her husband died, leaving her with a two-year-old daughter and incompleted graduate studies. With a full-time job and a child, Dr. Stroud took 14 years to reach her goal. However, she not only received a Ph.D. degree, but she won the A. Cressy Morrison Prize in natural sciences from the N.Y. Academy of Sciences. She also remarried at that time.

It was then that she and her new husband began to look for a warmer climate, and decided to move to California, where she worked at the Jet Propulsion Laboratory using, according to Dr. Stroud, the "spaceage technology to study chromosomes."

Another six years would go by before, as Dr. Stroud says, she was able to "make the full circle". She returned to her native New Mexico and to Los Alamos Scientific Laboratory, where she continues her research on the effects of radiation on the cells of animal tissue, particularly the chromosomal effects.

Her active, busy life includes tennis and golf. She uses her tennis-playing abilities to raise money for charity. Her other hobbies include oil and watercolor painting and stamp collecting. She is especially interested in encouraging young girls to consider scientific careers, but she also feels it is important to train boys to accept women in these careers because, as she sees it: "There still prevails the negative attitude of men against women when women are competing with them . . . Until parents teach their sons that women are their equals, this attitude will prevail."

EDUCATION: B.S. Biology, 1945, University of New Mexico
Ph.D. Biological Sciences, 1966, University of Chicago

Dr. Judith Anne Harris Van Couvering, Paleontologist

Assistant Professor of Geological Sciences and
Curator of Fossil Vertebrates, University of Colorado, Boulder

Dr. Van Couvering thought that she would be a secretary; therefore, in high school, she took a business course. But, just in case, she also took college preparatory courses. It is fortunate that she did because the opportunity to go to college did occur. She began as a psychology major, but a chance meeting at a party with a young geologist changed the course of her life. She switched majors to paleontology and she married the geologist, embarking on a hectic life which included raising four children while earning a bachelor's degree in paleontology, a Ph.D. degree in geology, and living in Africa and England.

Dr. Van Couvering considers Louis Leakey, the famous anthropologist, a major influence in her life. In another chance event she attended Leakey's lecture in California and learned that he needed a geologist for his expedition to Africa. She just happened to know one. When she suggested to her husband that he might be that geologist, he agreed and interviewed for the job while driving Leakey to the airport. Leakey also agreed. Her husband got the job and the Van Couverings moved to Africa.

After their African work, both husband and wife followed Leakey to Cambridge, England to work on their Ph.D.'s in geology, with her specializing in fossil vertebrates. This resulted in another research project in Africa,which Dr. Van Couvering describes as somewhat chaotic,since all of her children were there to help. It is fortunate that children like to dig.

The next episode in Dr. Van Couvering's life brought her to the University of Colorado in Boulder, where she now teaches advanced vertebrate paleontology and is curator of fossil vertebrates at the university's Natural History Museum. The museum work includes doing research, taking care of the fossil collection, and forming new collections. She enjoys her work, and considers one positive aspect to be the opportunity to wear old clothes and get dirty. She thinks it is a rewarding field, especially for women. According to Dr. Van Couvering, "You can put a lot of different parts of yourself into it if you are creative."

She also observes that "women . . . tend to be more whole people, or at least, desire to live with their whole selves." She feels that "this should be of great benefit to science because it leads to creativity rather than just technology." In her opinion, "the more women in the field the better it will be for men, women, and science."

EDUCATION: B.A. Paleontology, 1960, University of California-Berkeley
Ph.D. Geology, 1972, University of Cambridge, Cambridge, England

HOW HIGH THE SKY?

HOW FAR THE MOON?

An Educational Program for Girls and Women in Math and Science
Lafayette, Colorado

Women's Educational Equity Act Program
U.S. Department of Health, Education, and Welfare
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SHARON L. MENARD

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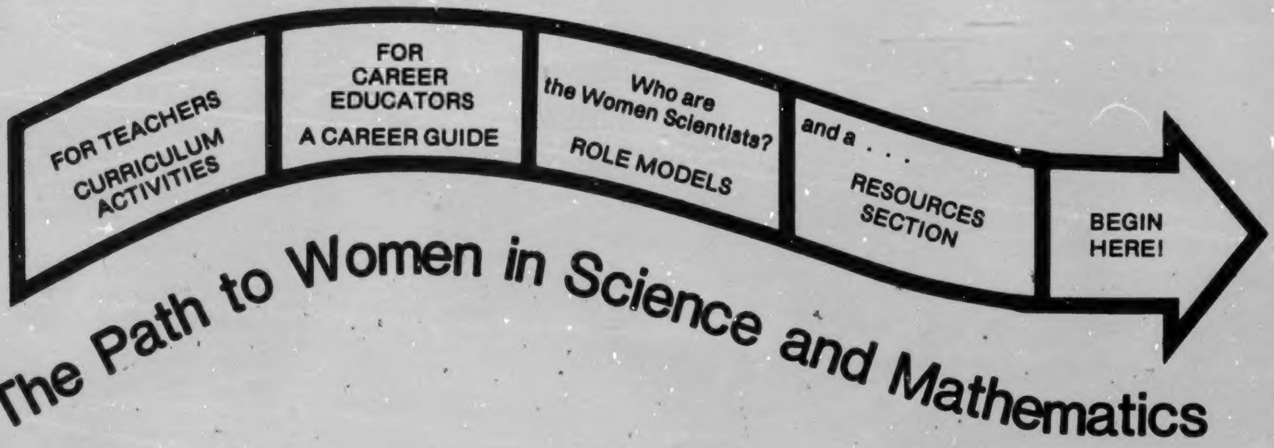

"Curiouser and curiouser!" cried Alice . . .

ALICE IN WONDERLAND
Lewis Carroll, a mathematician

How high the sky? How far the moon? These are questions asked by children. But how many children actually go on to find the answers? And of those who do, how many are girls? Actually, the answers to the first two questions may not be important. What is important is the curiosity, the inquisitiveness, the willingness to explore behind them. Too often these qualities, essential to the development of scientific talent, are met with restrictions and annoyance on the part of adults, who see the exploring child as apt to get into trouble, to cause inconvenience to the adult, or, in the case of little girls, to display behavior that is not appropriately feminine.

What if Alice had lacked curiosity? Would she have gone down the rabbit hole? And, a more important question: Would she have had any adventures? Would her mind have been receptive to a Wonderland? Would Wonderland have been created at all?

All of these are academic questions, really, since Alice did have curiosity, Alice did have adventures, and Wonderland was created with Alice's curious mind exploring it all.

How many little girls do you know who are missing Wonderland because their minds block it out? What happened to their curiosity? Are they encouraged to be curious? Are they discouraged from exploring rabbit holes or any other strange phenomenon that passes their way? If the 1974 national figures for scientists are any indication, the answer is: QUITE A FEW. Of the approximately two million scientists in the United States, about 9.4 percent were women. In addition, less than five percent of all scientists and engineers of both sexes in 1974 (87,000) were members of minority groups.* Are the low numbers of women scientists due to a difference in abilities between the sexes? Or are there other reasons?

Science and mathematics suffer from a mystique that has caused it to be set apart from everyday life and regarded as only for the absolutely brilliant or for the eccentric who displays anti-social behavior. This mystique creates a hardship on the woman because pressures to conform are even stronger for her.

But, science is part of our American way of life. It is part of everyday life. Adding to our scientific knowledge can, even for the nonscientist, add to our enjoyment of living and our knowledge of life. It is natural — there is nothing mysterious about it. The learning of science can be a pleasure to both sexes if it is not regarded as strictly a classroom subject and if it is not regarded as a field of study within the capabilities of only one sex.

Children should ask "How high the sky? How far the moon?" They should keep on asking these questions. They should be encouraged to ask and ask and seek and seek to satisfy their own curiosity. This should include the little Alices. "Why does water boil? Why does water freeze? How does a seed become a flower?" Our children and their minds are our most important resource.

In addition, children should meet and learn about scientists and what they do. We live in a complex technical society. This will be increasingly so. Many of the problems of the future will require well-developed minds to solve our problems. Half of those minds belong to girls. Extra efforts must be made to stimulate their creativity and to encourage them to be adventurous, curious, and competitive. Without this encouragement, girls may grow up to find that they have not only limited their options, but also cut themselves out of a large percentage of the job market — engineering, technical jobs, jobs requiring mathematical skills such as physics, chemistry, medicine, computer programming, and accounting. These challenging jobs are also the better paid positions.

The purposes of this packet of resource materials are:

1. To assist educators in recognizing scientific talent and in counseling girls to prepare themselves for scientific and technical jobs.
2. To make science and mathematics relevant to everyday life.
3. To provide information about scientific careers.
4. To provide information about women scientists, including their work and personal lives.
5. To provide sources of information about women scientists and about scientific matters.

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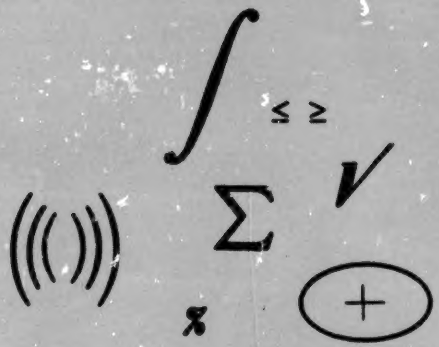
*Source: WOMEN AND MINORITIES IN SCIENCE AND ENGINEERING, National Science Foundation. U.S. Government Printing Office #038-000-00307.

The materials are organized in the following manner:

CURRICULUM SECTION:	Skill activities that can be used at various levels (K-12) in a short period of time. They will help develop scientific and mathematical skills and show the relevance of these to technical jobs.
CAREER SECTION:	A guide to selected scientific careers, with career exploration activities for the educator to use to help young women develop their awareness of the scientific fields.
RESOURCES SECTION:	An annotated list of materials, including juvenile fiction and nonprint media, that introduce scientific topics, female role models, and biographies of women scientists.
ROLE MODELS SECTION:	Information about women scientists — their work and scientific achievements.

These materials may be regarded as one book, or each section can be used independently or the sections combined in various ways. Some combinations are suggested; others can be designed by the educator. However they are used, the materials should provide a comprehensive approach to the world of women in science.



CURRICULUM ACTIVITIES

Dear Teacher,

The questioning approach is essential to the budding young scientist. Do you have potential scientists in your class? What can you do to encourage and to guide this potential? Are any of these potential scientists girls? Or, have you assumed that girls are not interested in science or mathematics or mechanical things?

Research evidence does not indicate that the aptitude for science is uniquely male, yet many average boys become good scientists and few girls, average, good, or otherwise, become scientists. This disparity is not explainable as sex differences. The introduction to the CAREER GUIDE in this packet discusses factors which are essential to the potential scientist. One of these factors is the ACTIVATING FACTOR, which includes opportunities offered in school and in the special skills of a teacher.

In the next few pages, you will find skill activities which are short and complete and which can be used in a variety of ways within your curriculum. These activities are designed to make mathematics and science exciting, to help your students develop basic skills which will be useful in many aspects of their lives, and to address some problems that students frequently encounter while learning mathematics and science. I hope you will try a few of them.

Sharon L. Menard

GENERAL CONCEPTS

OLD FRIENDS OF THE SCIENTIST:

Why? How?
What do we know?
How do we know what we know?
How well do we know what we know?

In teaching mathematical and scientific skills, here are some GENERAL CONCEPTS to keep in mind:

*** Don't teach mathematics and science! TEACH CHILDREN HOW TO LEARN THESE SUBJECTS.

*** De-emphasize "right" and "wrong" answers. Rather, give special attention to procedure.

*** Emphasize mathematical reasoning, the scientific method, and applications. These will be useful in other fields as well as the physical sciences.

*** Encourage flexibility, perceptual restructuring, and problem-solving abilities.

*** Teach the distinction between a good guess and a bad guess; a good error and a bad error.

*** Teach mechanical skills as well as concepts. They have a place in mathematics and science.

*** Show that mathematics and science are relevant to other subjects and to everyday living. Discover mathematical structures and scientific process in other subjects — music, art, home economics.

*** Teach the vocabulary of mathematics and science.

*** Use a historical-cultural approach by emphasizing people of different cultural backgrounds who made discoveries in mathematics and science.

*** Provide female role models in mathematics and science.

*** Use recreational and intuitive forms of mathematics such as puzzles.

SKILL ACTIVITIES

ACTIVITY	LEVEL
# 1 “One Thing I Wonder About . . .”	Primary (grades K-3)
# 2 Understanding Procedure	Primary, Intermediate (grades 4-6)
# 3 Vocabulary Words (Mathematical Language)	Primary, Intermediate
# 4 Check Your Characteristics (Classification System)	Primary, Intermediate
# 5 Reading and Writing Word Problems	Primary, Intermediate
# 6 Using Clues (Mysteries, Puzzles)	Primary, Intermediate, Junior High
# 7 Reading a Map	Intermediate, Junior High
# 8 Science and Mathematics in the Kitchen	Primary, Intermediate, Junior High
# 9 Using Tools	Primary, Intermediate, Junior High
#10 Mirrors	Intermediate
#11 Finding the Scientist	Intermediate, Junior High
#12 Career Scrapbook	Intermediate, Junior High
#13 Family Finances	Junior High
#14 Locating Jobs for Which Mathematics and Science Skills Are Needed	Intermediate, Junior High
#15 Women in Science Booklet	Intermediate, Junior High
#16 Famous Women Scientists	Intermediate, Junior High, Senior High
#17 Using Statistics	Junior High, Senior High
#18 Moments in Science History	Junior High, Senior High
#19 Lost Women of Science	Junior High, Senior High
#20 Interviewing	Junior High, Senior High
#21 “With My Abilities I Could Be . . .”	Junior High, Senior High
#22 Time Capsule Letter	Junior High, Senior High

Additional Scientific Activities for Senior High School Students

SKILL ACTIVITY #1: "ONE THING I WONDER ABOUT . . ."

LEVEL: Primary

OBJECTIVES:

1. To encourage curiosity
2. To learn scientific methods
3. To learn research methods
4. To obtain answers to questions

ACTIVITY DESCRIPTION:

Each student completes in writing, or orally, the sentence, "One thing I wonder about..." Then the student is guided by the teacher into how and where he or she can learn about the "thing" he or she wonders about. The student learns to answer his or her own questions.

MATERIALS REQUIRED:

Paper and pencil, encyclopedia, dictionary, other sources of information, as appropriate

INSTRUCTIONS:

1. Depending on grade level, student completes the sentence, "One thing I wonder about . . ." This can be written by the student, told to the teacher, or recorded on cassette tape.
2. Respond to the statement by writing or telling students where or from whom they might locate the information needed.
3. Information can be presented to entire class by the student. Sources of information might also be shared.

DISCUSSION:

1. Where did the student find the information?
2. Where else might this information be found?
3. What other kind of information was available through the source used?
4. Did anyone else in the class ever wonder about the same thing? If so, did they ever try to find out more about it? Where? If not, why not?

REFERENCES:

Adler, Irving and Ruth. WHY? A BOOK OF REASONS
New York: The John Day Co., 1961

Adler, Irving and Ruth. WHY AND HOW? A SECOND BOOK OF REASONS
New York: The John Day Co., 1963

SKILL ACTIVITY #2: UNDERSTANDING PROCEDURE

LEVEL: Primary, Intermediate

OBJECTIVES:

1. To develop the student's understanding of mathematical procedures
2. To check the student's understanding of mathematical procedures
3. To emphasize the importance of logical reasoning along with finding the answer
4. To encourage a discovery approach to problem-solving

ACTIVITY DESCRIPTION:

While working a mathematics problem, the student explains his or her assumptions and procedures, either to the teacher or to a tape recorder. The teacher reviews the student's approach and responds to the student.

MATERIALS REQUIRED:

Pencil and paper, mathematics problems, tape recorder (optional)

INSTRUCTIONS:

1. Each student works independently to solve a mathematics problem.
2. After completion of the problem, he or she explains to the teacher (or members of the class or to a tape recorder):
    a. assumptions made in working the problem.
    b. procedures used to arrive at an answer.
3. Examine the procedures and assumptions to determine the student's understanding of the problem. Allow for alternate approaches to problem solving. Look for faulty reasoning rather than right or wrong answers.
4. If reasoning is faulty, go over the procedure, pointing out procedural errors and explaining appropriate procedure.
5. Give lots of praise for parts that were well done.

DISCUSSION:

1. What were the common procedural errors?
2. What were the common erroneous assumptions?
3. Why do you think these errors happen?
4. What difficulties arise when these errors are made?
5. How can you check for errors? What clues are there?

SKILL ACTIVITY # 3: VOCABULARY WORDS (MATHEMATICAL LANGUAGE)

LEVEL: Primary, Intermediate

OBJECTIVES:

1. To develop the student's understanding of commonly used words in mathematics problems
2. To learn how words translate into computational symbols

ACTIVITY DESCRIPTION: Words commonly used in mathematics problems are discussed and explained to students. Words are translated into mathematical symbols.

MATERIALS REQUIRED: Words, word problems. Here are some that may be misunderstood by the student (you can add your own):

plus (add)
minus (subtract) (take away)
equal (is)
times (multiply)
into (divide)
part of (fractions)
one-half of (percentage)

INSTRUCTIONS:

1. Identify commonly-used words in mathematical problems or statements, such as the ones listed under MATERIALS REQUIRED.
2. Translate their meaning into mathematical computation symbols, such as add, subtract, etc.
3. Explain the symbols and meanings to the students.
4. Test their understanding in a series of word problems, by having them write the mathematical procedure to be used.

DISCUSSION: Ask the students to give examples of situations in which the vocabulary words might be used.

REFERENCE: This approach can also be applied to scientific vocabulary. An excellent resource is:

Asimov, Isaac. WORDS OF SCIENCE AND THE HISTORY BEHIND THEM
Boston: Houghton-Mifflin Co., 1959

Useful at the intermediate level. Besides giving technical information, it also gives the origin of the word.

SKILL ACTIVITY #4: CHECK YOUR CHARACTERISTICS (CLASSIFICATION SYSTEM)

LEVEL: Primary; Intermediate

OBJECTIVES:

1. To develop self-awareness
2. To develop observational skills
3. To learn ways of classifying data
4. To learn methods of organizing data
5. To learn graphing methods

ACTIVITY DESCRIPTION:

The student's personal characteristics, such as eye color, are noted and classified. He or she organizes and compares data with other members of the class and presents the data in a graph.

MATERIALS REQUIRED:

Pencil and paper, craft paper, newsprint paper, magic markers

INSTRUCTIONS:

1. Have each student list personal characteristics for selected categories, such as eye color, height, age, or birth date.
2. Summarize characteristics for the class in a statistical form, for example:

   EYES — brown: 4
   blue: 5

3. Have the students, using large sheets of paper or colored craft paper and magic markers, plot the data in two graphical forms:
   a. line graphs
   b. bar graphs
4. Have the students explain the graphs and their meanings.

DISCUSSION:

1. What is a maximum?
2. What is a minimum?
3. What is an average?

SKILL ACTIVITY #5: READING AND WRITING WORD PROBLEMS

LEVEL: Primary, Intermediate

OBJECTIVES:

1. To develop mathematical vocabulary
2. To provide auditory training for mathematical language
3. To develop skill in mental translation of mathematical language to computational symbols

ACTIVITY DESCRIPTION:

Mathematical problems are read aloud and students verbally translate the problems into computational procedures.

MATERIALS REQUIRED:

Mathematics problems, tape recorder (optional)

INSTRUCTIONS:

1. Teacher reads mathematics problem aloud. A tape recorder can also be used for this.
2. The students identify the mathematical operations which are necessary to solve the problem, e.g. addition.
3. The students write the procedure for working the problem.
4. After some training, the students can work in a buddy system, taking turns reading problems to each other.
5. After the students have practiced reading problems, have them write their own word problems. Then follow this by having them write the procedure for working the problem.
6. Working the problem may not be necessary every time.

DISCUSSION:

1. Why do you think the identified operation will work?
2. What other operations might be used to solve the problem?

SKILL ACTIVITY #6: USING CLUES (MYSTERIES; PUZZLES)

LEVEL: Primary, Intermediate, Junior High

OBJECTIVES:

1. To learn problem-solving
2. To provide training in observational skills
3. To learn logic and procedures

ACTIVITY DESCRIPTION:

Mysteries, puzzles, games, and riddles are used for training in problem solving and logical reasoning.

MATERIALS REQUIRED:

Jig-saw puzzles, riddles, mathematical games, mysteries. These can be from your own collection or from the references listed below.

INSTRUCTIONS:

1. Give problem (puzzle, etc.) to students.
2. Check that the students understand what the problem is — e.g. what is known (essential clues) and what is not known. Do this by asking the student to state the problem. Ask leading questions if the student has omitted anything.
3. Have the students try various problem-solving approaches, for example:
   a. compare the problem with other problems they may have done before.
   b. restate the problem in their own words
   c. work only part of the problem (the part which they understand or can solve)
4. After the students have worked out a solution, follow up by having students explain their approach to each other.

DISCUSSION:

1. What is the unknown?
2. Have you seen this problem before? Is it similar to another problem, but in a different form?
3. Can you solve part of the problem?
4. Have you used all of the known data which is given?
5. Have you checked the result? Does it satisfy the given conditions?

REFERENCES:

Hartman, Arlene. THE CALCULATOR BOOK FOR KIDS OF ALL AGES
New York: Signet Book, New American Library, 1977

Games to play with a calculator. Grade levels are given. Chapter 8 contains puzzles and games for one player.

Linn, Charles F. PUZZLES, PATTERNS, AND PASTIMES; FROM THE WORLD OF MATHEMATICS
New York: Doubleday, 1969

186 modern and ancient teasers to test mathematical logic. Intermediate-junior high level.

SKILL ACTIVITY #6, con't:

Gardner, Martin. SCIENCE PUZZLERS
New York: Viking Press, 1960

A series of scientific experiments which do not require special equipment and which are entertaining. Intermediate-junior high level.

Mayer, Jerome S. FUN WITH MATHEMATICS
New York: World Publishing Co., 1952

For the high school level, this book is more mathematically orientad than the above.

Polya, G. HOW TO SOLVE IT
Princeton, N.J.: Princeton University Press, 1973

Background reading for the teacher.

SKILL ACTIVITY #7: READING A MAP

LEVEL: Intermediate, Junior High

OBJECTIVES:

1. To develop map reading skills
2. To develop spatial relationships
3. To learn measurement, scale, map concepts, such as north and Cartesian coordinates

ACTIVITY DESCRIPTION:

Maps are searched for particular locations. The locations are described in terms of their position with respect to each other. Distances are measured.

MATERIALS REQUIRED:

Maps such as road maps, U.S. Geologic Survey maps, scale for measurement

INSTRUCTIONS:

1. Give students a list of places to locate on the maps, such as cities or towns or highway intersections. Have them mark the locations.
2. Review maps for legend and other symbols.
3. Have students write or say a description for places on the map, e.g. town A is north and east of town B. Or, town A is at A3.
4. Have students measure distances between locations. Specify accuracy of measurement. Have them translate measurements to actual distances.

DISCUSSION:

1. How are maps made?
2. Who makes maps?
3. How are distances determined?
4. What is the relationship between the map scale and actual distances?
5. How reliable is the map?

SKILL ACTIVITY #8: SCIENCE AND MATHEMATICS IN THE KITCHEN

LEVEL: Primary, Intermediate, Junior High

OBJECTIVES:

1. To learn science and mathematics applications
2. To develop awareness of science and mathematics in other subjects
3. To learn that science and mathematics are part of everyday life

ACTIVITY DESCRIPTION: Science and mathematics are used and explained as part of kitchen activities.

MATERIALS REQUIRED: Recipes, food, kitchen equipment and supplies

INSTRUCTIONS:

1. Select a recipe. For the primary level, the recipe can be written on large sheets of paper using pictures to illustrate cups, teaspoons, etc.
2. Use the measurements to explain fractions, e.g. half cup; one-fourth of a teaspoon.
3. Have students note and try to explain the physical and chemical change process as the recipe is carried out and the food is cooked.
4. Introduce science vocabulary, e.g. molecules, boiling point.
5. Other activities include using kitchen chemicals to experiment with chemical reactions. Shalit has experiments which can be done with soap, salad oil and tea. Any cookbook for children will also supply some appropriate recipes.

DISCUSSION:

1. Why does water boil?
2. What does your sense of taste tell you about substances, e.g. acids, salts?
3. What does color tell you in the cooking process?

REFERENCES:

Shalit, Nathan. CUP AND SAUCER CHEMISTRY
New York: Grosset & Dunlap, 1974
Viorst, Judith. 150 SCIENCE EXPERIMENTS
STEP-BY-STEP
New York: Bantam Books, 1973

If you want to expand the concept of this activity, the following reference may be useful:

Simon, Seymour. SCIENCE IN A VACANT LOT
New York: Viking Press, 1970

SKILL ACTIVITY #9: USING TOOLS

LEVEL: Primary, Intermediate, Junior High

OBJECTIVES:

1. To learn the use of hand tools
2. To develop applied science skills
3. To enhance mechanical aptitude

ACTIVITY DESCRIPTION: Hand tools are identified and demonstrated. Principles behind familiar engines and machines are explained.

MATERIALS REQUIRED: A selection of hand tools, a bicycle, automobile engine.

INSTRUCTIONS:

1. Display a selection of hand tools, such as hammer, screwdriver, pliers, etc. Name each tool, explain how it works and the scientific principle behind its operation. Demonstrate its use. (You might have a speaker come to the class and do this or make it part of a field trip. Try to find a woman who can do this.)
2. Have the students practice with the tools themselves.
3. Follow up with a unit on bicycle repair or automobile repair, depending on the grade level. This can be done by speaker or field trip.
4. In connection with the tools and repair units, teach a unit from the reference listed below.

DISCUSSION:

1. Where are the hand tools located in your house?
2. Who uses them?
3. When are they used?
4. What are some of the things you can do with these tools? What could you repair?

REFERENCE:

Keen, Martin L. HOW IT WORKS.
New York: Grosset & Dunlap, 1974

Simple explanations of the principles of common, familiar machines, such as the telephone, tape recorder, light bulbs, electric toaster, electric iron, vacuum cleaner, flashlight, internal combustion machine, and ball-point pen.

RELATED ACTIVITIES: Plan a field trip to a hardware store. Or, bring a box of nuts and bolts, wires, etc. to school and let students handle them and try them. This is a good classifying activity for the primary level.

SKILL ACTIVITY #10: MIRRORS

LEVEL: Intermediate

OBJECTIVES:

1. To develop self-awareness
2. To create awareness of scientific and technical occupations

ACTIVITY DESCRIPTION:

The students choose, cut, and paste pictures from magazines which reflect their self-image.

MATERIALS REQUIRED:

Magazines which can be cut up; scissors; paste; large sheets of paper, poster board, or cardboard.

INSTRUCTIONS:

1. Have students look through magazines in class or at home.
2. Have students cut out pictures that they feel reflect themselves or their desires.
3. Then, on large sheets of paper or poster board, have them arrange and paste the pictures to display their image of themselves.
4. The students can display their "mirrors" and tell the class what they see in their own "mirrors." Other class members can help them look.

DISCUSSION:

1. What do you see in your "mirror"?
2. What do others see in your "mirror"?
3. Do you see a scientist in your "mirror"? Why? Why not?
4. What do you think a scientist does?

REFERENCE:

CAREER GUIDE in this packet.

SKILL ACTIVITY #11: FINDING THE SCIENTIST

LEVEL: Intermediate, Junior High

OBJECTIVES:

1. To create awareness of scientific and technical occupations
2. To research information about the work of a scientist

ACTIVITY DESCRIPTION:

Using magazines, books, newspapers, or any other appropriate material, examples of scientists are searched for.

MATERIALS REQUIRED: Magazines, books, newspapers, other materials

INSTRUCTIONS:

1. Choose appropriate source material, as suggested, which has pictures of scientists.
2. Have students search these materials for examples of scientists.
3. Have students observe the kind of scientist and note any information about the work and/or personal activities of the scientist.
4. Have students present their examples and information to the class.

DISCUSSION:

1. Were examples of scientists hard to find? Why? Why not?
2. What kind of work does a scientist do?
3. What skills does a scientist need?
4. What physical environment does the scientist work in?
5. Did you find any women scientists?
6. Can a woman be a scientist? Why? Why not?
7. Would you like to be a scientist? Why? Why not?

REFERENCES:

CAREER GUIDE in this packet
RESOURCES in this packet

SKILL ACTIVITY #12: CAREER SCRAPBOOK

LEVEL: Intermediate, Junior High

OBJECTIVES:

1. To develop awareness of scientific and technical occupations
2. To research information about scientific and technical occupations

ACTIVITY DESCRIPTION:

The class keeps a scrapbook of magazine or newspaper clippings and other information on scientific and technical careers and topics.

MATERIALS REQUIRED:

Scrapbook or some form of notebook, magazines, newspapers

INSTRUCTIONS:

1. Over a period of time, have students collect materials about scientists, scientific work, and scientific topics. This could include student reports on women scientists.
2. Put collected materials in a scrapbook or notebook.
3. Have students take turns adding to the collection.
4. Rotate the scrapbook among class members so that all students have a chance to read it.
5. Allow other classes to borrow and add to the collection.
6. Perhaps you can donate it to the library or other classes or the counseling office as reference material.

DISCUSSION:

1. How many scientific occupations does the scrapbook identify?
2. What are they? What kind of work is involved?
3. Where does this work take place?
4. Are female scientists included? How many? What kind of work do they do?
5. How can you find out more about women scientists?

REFERENCES:

CAREER GUIDE in this packet
RESOURCES listed in this packet
ROLE MODELS in this packet

SKILL ACTIVITY #13: FAMILY FINANCES

LEVEL: Junior High

OBJECTIVES:

1. To develop mathematical skills
2. To learn a mathematical application
3. To learn the relevance of mathematics to everyday living
4. To become aware of the amount of money needed for everyday living

ACTIVITY DESCRIPTION:

The students will create a family budget, learn basic record keeping, and learn checking account procedures.

MATERIALS REQUIRED:

Pencil, paper, blank checks, deposit forms (if not available, students can make their own)

INSTRUCTIONS:

1. Set an upper limit on the amount of money each student is allowed to spend and has deposited in the bank.
2. Have students list the items to be included in their budget, e.g. food, clothing.
3. Have students allocate a certain amount of money for each item and have them show the basis for each allocation, e.g. dollars for food per month.
4. Have students substantiate their budget items and amounts as realistic estimates.
5. Provide bank checks and deposit forms.
6. Give the students a series of itemized bills to be paid, e.g. grocery bill, electric bill, clothing bill; and forms of income, e.g. paychecks, stock dividends, and bank interest.
7. Have students use these bills and income to make deposits and withdrawals from their checking accounts. They should fill in checks and deposit forms and keep a running balance of amounts in their checking accounts.
8. Have them design and set up a simple record-keeping system that enables them to compare their checking account balances with their total budget and budgeted items.
9. After a certain number of bills have been paid, have members of the class pair off and make out bank statements for each other, using filled out checks and deposit forms.
10. Have paired students compare bank statements to their check balances to see if they agree.

DISCUSSION:

1. Are budget items all necessary? Could some be omitted? Should some be added?
2. Are budget amounts reasonable? How can you find out?
3. Are you staying within your budget? If not, what can you do about it?
4. Does your bank balance agree with your checkbook balance? If not, why? Check for computation errors and entry omissions.

SKILL ACTIVITY #14: LOCATING JOBS FOR WHICH MATHEMATICS AND SCIENCE SKILLS ARE NEEDED

LEVEL: Intermediate, Junior High

1. To relate mathematics and science skills to current job market
2. To develop awareness of the job market
3. To learn job hunting procedures

ACTIVITY DESCRIPTION: Classified job advertisements are reviewed to identify jobs for which mathematics and science skills would be useful.

MATERIALS REQUIRED: Classified section of newspapers; other sources of job advertisements such as professional journals

INSTRUCTIONS:

1. Have students search classified advertisements for jobs which require mathematics and science skills.
2. If advertisements do not specifically ask for these skills, have students find ads for jobs in which these skills are implied, e.g. degree or training in certain scientific fields.
3. Have the students list and count the jobs found and label those which require college training and those which do not. If salary information is included, have them note that also.

DISCUSSION:

1. Are mathematics and science skills needed? In what ways?
2. Are mathematics and science skills needed in jobs which are not clearly scientific or technical? Give examples.
3. How do salaries compare for jobs which require mathematics and technical skills and those which do not?
4. What kind of mathematics and science skills, at what level, are necessary for which jobs?

REFERENCE: CAREER GUIDE in this packet

SKILL ACTIVITY #15: WOMEN IN SCIENCE BOOKLET

LEVEL: Intermediate, Junior High

OBJECTIVES:

1. To create awareness of women scientists
2. To develop research skills
3. To learn about the work and lives of women scientists

ACTIVITY DESCRIPTION:

A series of booklets with biographies of women scientists will be created.

MATERIALS REQUIRED:

Pencil and paper; notebook; resource materials such as encyclopedia, biographical dictionary, or selections listed in RESOURCES section.

INSTRUCTIONS:

1. Have students choose a woman scientist to study. Try to arrange a good cross-section of scientific disciplines. The scientist does not have to be famous or dead. Suggest that students use women whom they know personally.
2. Have students search for biographical information about the women scientists. Include:
   a. Description of their work
   b. Description of their work environment
   c. Information about their training
   d. Personal information such as life style and childhood, including the decision-making process that led them to become scientists
3. Have students prepare the biographies as booklets or notebooks. Include illustrations such as magazine clippings.
4. Encourage students to read each other's booklets.
5. Arrange an exhibit of the booklets for the rest of the school.
6. Donate booklets to the library.

DISCUSSION:

1. Why did you choose this particular woman?
2. Where did you find information about the woman? Was it hard to find?
3. What did you find most interesting about the woman and her work? Why?

REFERENCES:

RESOURCES section of this packet
ROLE MODELS section of this packet

SKILL ACTIVITY #16: FAMOUS WOMEN SCIENTISTS

LEVEL: Intermediate, Junior High, Senior High

OBJECTIVES:

1. To create awareness of women scientists
2. To develop research skills
3. To learn about the work and lives of women scientists

ACTIVITY DESCRIPTION:

Short talks are developed to be given to class or other groups, if desired, about notable women scientists.

MATERIALS REQUIRED:

Pencil and paper; resource materials such as encyclopedia, biographical dictionary, or selections listed in the RESOURCES section.

INSTRUCTIONS:

1. Have students choose a notable woman scientist to study. Try to arrange a good cross-section of women and scientific disciplines.
2. Have students search for biographical information about the scientists, such as:
   a. Description of their work
   b. Description of their work environment
   c. Information about their training
   d. Personal information such as life style and childhood, including the decision-making process that led them to become scientists
3. Have students prepare the information in short 10-15 minute talks to present to the class or other groups.

DISCUSSION:

1. Why did you choose this particular woman?
2. Where did you find information about this woman? Was it hard to find? Why? Why not?
3. What did you find most interesting about the woman? Why?
4. What makes her notable?
5. Do you think other women could do what she did? Why? Why not?
6. Do you think men could do what she did? Why? Why not?

REFERENCES:

RESOURCES section of this packet
ROLE MODELS section of this packet

SKILL ACTIVITY #17: USING STATISTICS

LEVEL: Junior High, Senior High

OBJECTIVES:

1. To teach data representation and interpretation
2. To develop awareness of the status of women scientists

ACTIVITY DESCRIPTION:

Statistics are presented in tabular form and the data are interpreted to learn about women scientists.

MATERIALS REQUIRED:

Women Scientists Data Sheet (on next page)

INSTRUCTIONS:

1. Have students read the Women Scientists Data Sheet.
2. Have students write the following information:
    a. Number of women who are (choose scientific field(s))
    b. Salary of female (choose scientific field(s))
    c. Salary of male (choose same scientific field(s) as those chosen for women)
    d. Compute the difference between the two salaries.
    e. Compute the percentage that the female salary is of the male salary.
    f. Number of minority people who are scientists
    g. Number of minority scientists who are female
    h. Compute the percentage of minority scientists who are female.
    i. Compute the percentage of the total number of scientists who are female and members of a minority group.

DISCUSSION:

1. Why do you think there are more male scientists than female scientists?
2. Why do you think male scientists' salaries are greater than female scientists?
3. Why do you think there are so few minority scientists?
4. What other ways can you think of to present these data? (e.g. graphs, parts of circles)

REFERENCE:

WOMEN AND MINORITIES IN SCIENCE
AND ENGINEERING
National Science Foundation Publication
U.S. Government Printing Office #038-000-00307

WOMEN SCIENTISTS DATA SHEET

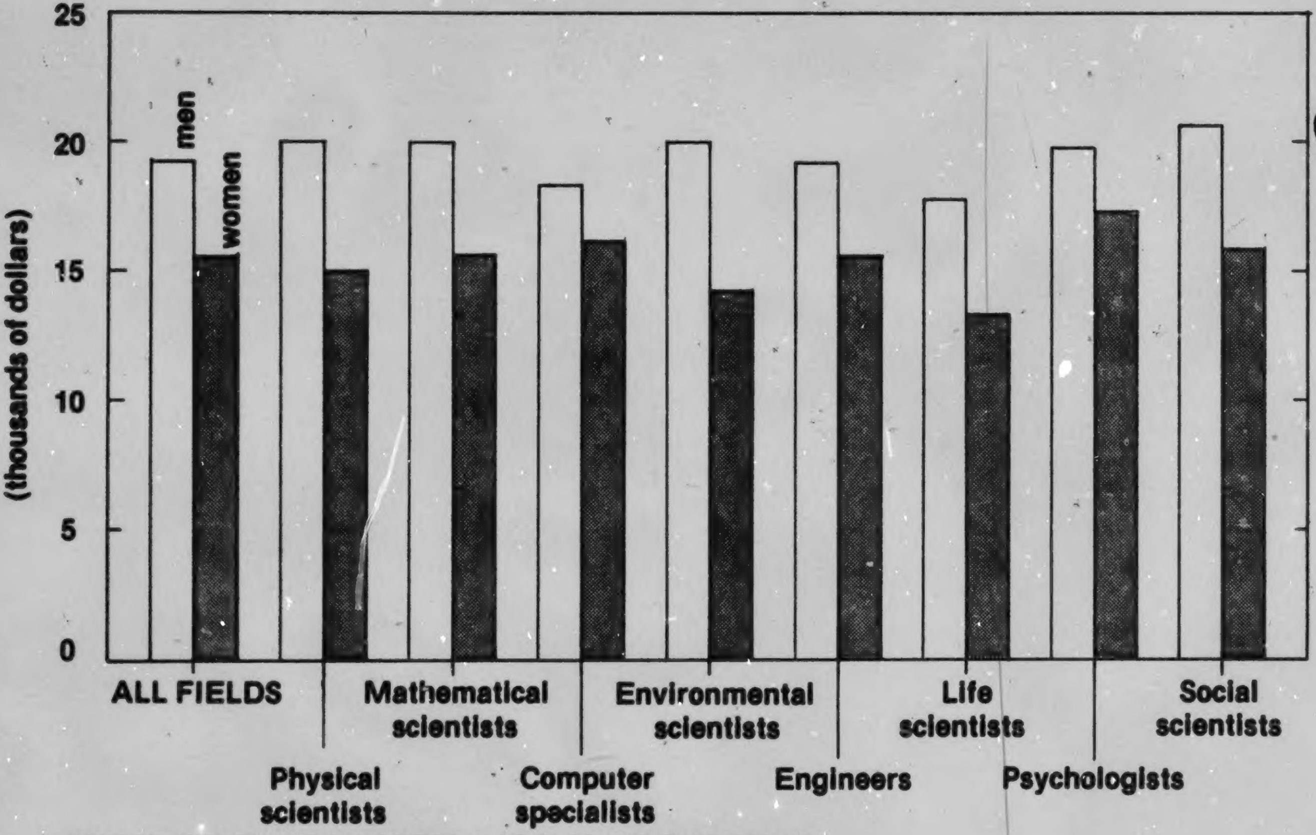
Scientists and engineers by field, sex, and race: 1974

Field	Total	Sex		Race				
		Male	Female	White	Black	Am Indian	Asian	Other
Total	1,973,000	1,788,000	185,000	1,886,000	31,700	1,800	36,500	17,000
Physical scientists	188,000	170,000	18,000	179,000	3,500	(1)	4,600	1,300
Mathematical scientists	60,000	45,200	15,000	57,000	1,900	(1)	1,300	(1)
Computer specialists	125,000	101,000	24,000	120,000	2,500	(1)	1,300	700
Environmental scientists	52,000	49,000	3,000	51,000	100	(1)	500	(1)
Engineers	1,072,000	1,064,000	8,000	1,035,000	8,500	500	20,200	8,100
Life scientists	194,000	160,000	34,000	184,000	3,500	(1)	2,700	3,300
Psychologists	95,000	68,000	27,000	90,000	1,600	(1)	2,600	800
Social scientists	187,000	131,000	56,000	172,000	10,200	500	2,200	2,100

[1] — Less than 500

NOTE: Detail may not add to total because of rounding.

Annual salaries of scientists and engineers, by field and sex: 1974



SOURCE: WOMEN AND MINORITIES IN SCIENCE AND ENGINEERING
National Science Foundation Publication
U.S. Government Printing Office #038-000-00307

SKILL ACTIVITY #18: MOMENTS IN SCIENCE HISTORY

LEVEL: Junior High, Senior High

OBJECTIVES:

1. To create awareness of women in science
2. To develop a sense of living history
3. To develop writing skills

MATERIALS REQUIRED: Pencil and paper; resource materials such as encyclopedia, biographical dictionary, RESOURCES section of this packet; tape recorder (optional)

ACTIVITY DESCRIPTION: The script for a minute in the life of a woman scientist is created.

INSTRUCTIONS:

1. Have the students choose a woman scientist. (You may want to make these team projects.) Try to arrange a cross-section of women in various scientific disciplines.
2. Have the students research information about the women.
3. Have students write a script for a one-minute public service announcement (which might be used on radio or television) about the women.
4. Have students present their scripts to the class or other groups.
5. Tape record the scripts having students supply voices in the scripts.
6. Lend tapes to other classes.
7. Donate tapes to library.
8. If possible, arrange for the local broadcasting stations to use them.

DISCUSSION: What do you think it is like to be the woman scientist in the script?

REFERENCES:

RESOURCES section of this packet
ROLE MODELS section of this packet

SKILL ACTIVITY #19: LOST WOMEN OF SCIENCE

LEVEL: Junior High, Senior High

OBJECTIVES:

1. To create awareness of women scientists and their work
2. To develop research skills

ACTIVITY DESCRIPTION:

The work and dates of the work of women scientists are listed.

MATERIALS REQUIRED:

Women Scientists list (on next page or create your own); encyclopedia, biographical dictionary, or RESOURCES included in this packet.

INSTRUCTIONS:

1. Give students copies of the list of women scientists.
2. Have students research the scientific contributions of the women and the time of the work.
3. Have students complete the list.
4. Have students include their research bibliography with their list.
5. Collect lists and identify those women on the list for which no information was found. Add the information or direct the students to where they can find the information.
6. Have students take turns presenting their findings about each woman.
7. OPTIONAL INSTRUCTION: order posters listed in the Poster part of the RESOURCES section.

DISCUSSION:

1. Where was the information about the women located? Was it hard to find? If it was hard to find, why do you think this is so?
2. Were the contributions of women scientists surprising to you? If they were a surprise, why?

REFERENCES:

RESOURCES section of this packet
ROLE MODELS section of this packet

WOMEN SCIENTISTS LIST

How many women scientists can you name? How many mathematicians and engineers? Most people can think of at least one — Marie Curie, who won two Nobel Prizes, one in physics and one in chemistry. In addition, her daughter, Irene Joliet-Curie, won a Nobel Prize in chemistry, becoming the second female Nobelist. How many of the following women can you identify? Do you know about their work and when they did it?

NAME	HER WORK	TIME PERIOD
Annie Jump Cannon		
Rachel Carson		
Gerty Cori		
Maria Goeppert-Mayer		
Alice Hamilton		
Florence Sabin		
Helen Taussig		
Grace Hopper		
Hypatia		
Maria Mitchell		
Lise Meitner		
Chien-Shiung Wu		
Lillian Gilbreth		
Ellen Richards Swallow		
Ada Byron Lovelace		
Mary Somerville		
Jane Goodall		
Virginia Apgar		
Sonya Kovalevski		

SKILL ACTIVITY #20: INTERVIEWING

LEVEL: Junior High, Senior High

OBJECTIVES:

1. To create awareness of contemporary women scientists
2. To research in-depth information about scientific work and the personal lives of women scientists
3. To learn interviewing skills
4. To learn techniques of oral history

ACTIVITY DESCRIPTION:

Women scientists in local community are interviewed about their work, training, and personal lives

MATERIALS REQUIRED:

A set of interview questions, tape recorder (optional)

INSTRUCTIONS:

1. Have a group of students locate women scientists who are willing to be interviewed.
2. Have class design a set of questions to be used in the interview. Having the students do this is very valuable because they have the opportunity to learn what they want to know. Suggested questions are included on INTERVIEW QUESTIONS page (see next page).
3. Have the students interview the women scientists. Give them the option of:
    a. Writing the interview.
    b. Taping the interview.
    c. Bringing the scientist to class and conducting the interview as part of a class presentation. (If several students choose this option, a panel format might be used.)
4. Have students present the results of their interviews in class.

DISCUSSION:

1. What part of the interview interested you the most? Why?
2. Did you learn anything new? What was it?
3. Did anything about the woman, her work, or her life surprise you? If so, what was it? Why?
4. Would you like to get to know this woman better? Why?

SAMPLE INTERVIEW QUESTIONS

WHAT IS YOUR JOB?
- — What do you do?
- — Describe the physical and human environment.

WHAT ARE THE JOB DEMANDS? SATISFACTIONS? FRUSTRATIONS?

WHAT KIND OF PERSON WOULD ENJOY DOING YOUR WORK?

WHAT EDUCATION OR TRAINING BACKGROUND IS REQUIRED?

WHAT KIND OF PERSON WOULD NOT ENJOY DOING YOUR WORK?

WHAT HAVE BEEN YOUR CHANCES FOR ADVANCEMENT?

WHAT HAS BEEN THE COMPETITION?

WHAT INITIATIVES HAVE YOU TAKEN IN YOUR CAREER?

WHAT OBSTACLES HAVE YOU ENCOUNTERED?

WHAT IS IT LIKE TO BE A WOMAN IN THIS JOB?
- — What have been the responses of your family and co-workers?

HOW DOES YOUR JOB FIT WITH MARRIAGE? CHILDBEARING?

HOW DID YOU GET WHERE YOU ARE?

- — What was the decision-making process with respect to your:
  - early life?
  - teachers?
  - parents?
  - family circumstances?

WHAT ADVICE CAN YOU OFFER OTHER WOMEN?

SKILL ACTIVITY #21: "WITH MY ABILITIES I COULD BE . . ."

LEVEL: Junior High, Senior High

OBJECTIVES:

1. To develop self-awareness
2. To relate individual abilities to those required of a scientist

ACTIVITY DESCRIPTION:

The student identifies his or her abilities, interests, and desires and attempts to match these abilities to a list of scientific occupations.

MATERIALS REQUIRED:

Pencil and paper, list of scientific occupations.

INSTRUCTIONS:

1. Have the students make a list of their abilities, interests, and desires, as they see them.
2. Give them the list of scientific occupations and have them use the list to choose occupation which they think might be possible for them. (The students will probably have to guess at this, but let them do it anyway. They may have more than one.)
3. Then have them complete the statement: "With my abilities I could be . . ." with the reasons why.
4. Have the students present their completed statements to the class.
5. Help them by clarifying what each scientist on the list does.

DISCUSSION:

1. Do you know what all the occupations in the list are and what these people do? If not, give the needed information.
2. What skills do you think are necessary for these occupations?
3. What training do you think is necessary?
4. Why do you think you can be (the scientist selected)?
5. Would you like to be (the scientist selected)? Why? Why not?
6. Can women learn to fly an airplane; fix an automobile; design a bridge or a building; find a cure for the common cold?

REFERENCES:

CAREER GUIDE in this packet (The STUDENT CHECKLIST is useful.)
RESOURCES listed in this packet

LIST OF SCIENTIFIC OCCUPATIONS

MATHEMATICAL SCIENCES

- Mathematician
- Statistician
- Actuarial Scientist

PHYSICAL SCIENCES

- Astronomer
- Physicist
- Chemist

LIFE SCIENCES

- Zoologist
- Botanist
- Physiologist

EARTH SCIENCES

- Oceanographer
- Meteorologist
- Geologist

ENGINEERING

- Engineer
- Electronic Technician
- Drafter
- Surveyor

SKILL ACTIVITY #22: TIME CAPSULE LETTER

LEVEL: Junior High, Senior High

OBJECTIVES:

1. To create self-awareness
2. To create awareness of technical careers

ACTIVITY DESCRIPTION:

The student's conception of technical work is recorded and reviewed at a later time. (This is a good pre- and post-activity to use with a unit on technical careers.)

MATERIALS REQUIRED:

Pencils and paper

INSTRUCTIONS:

1. Have the students complete the following statement:

   ''If I were a (choose a technical field such as chemist, mathematician, electronic technician) or (choose a woman scientist such as Marie Curie),

   I would do these things:

   (student writes what he or she would do in that job or as that person).
2. Have students seal the statements in a container and store for some future time.
3. At future time, repeat step 1.
4. Unseal container and return statements to the students.
5. Have the students compare their two statements.

DISCUSSION:

1. How do the statements compare? Did you write about the same career or person both times? If not, why not? If so, have your impressions of that career or person changed? In what ways?
2. Do you know more about scientific work than you did before? If not, why not? If so, what kinds of things did you learn?
3. Would you like to do this kind of work? Why?

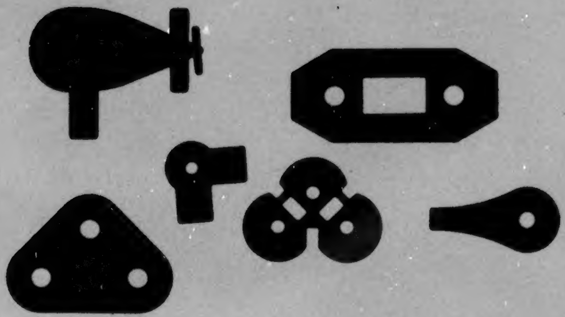
REFERENCES:

CAREER GUIDE in this packet
RESOURCES listed in this packet
ROLE MODELS section of this packet

ADDITIONAL SCIENTIFIC ACTIVITIES
FOR SENIOR HIGH SCHOOL STUDENTS

HERE ARE SOME IDEAS FOR THE SENIOR HIGH LEVEL. MAKE A SPECIAL EFFORT TO RECRUIT WOMEN STUDENTS.

1. Create a science column in the school newspaper dealing with, for example, scientific topics, scientists, and latest scientific breakthroughs.
2. Assist science teacher in his or her field of interest. (Also prepare teaching materials.)
3. Maintain a school museum of living and preserved specimens.
4. Read professional journals in mathematics, science, and engineering.
5. Form a science or science-related club. Some related interest clubs might be tropical fish, science research, photography, laboratory technology, or astronomy.
6. Work on independent science study projects under the guidance of a science teacher.
7. Establish a science honor society and/or a science and mathematics honors program to provide opportunities for students to:
    a. learn laboratory techniques (e.g. histology, bacteriology, analytical chemistry)
    b. learn use and operation of laboratory equipment (e.g. analytical balance, microscope, computers)
    c. gain skill in shopwork, including handling of common materials, wood, metal, etc.
    d. do library research (e.g. college textbooks, women scientists)
    e. do mathematical work or study advanced mathematics topics, including calculus
    f. prepare exhibits of science work for demonstration before other students, for science fairs, and for local exhibition
    g. prepare reports of science work for school newspaper, school science journal, or other publications
    h. participate in seminar activity on a regular basis



A CAREER GUIDE

to
scientific and
technical occupations

FOR WOMEN

Dear Career Educator,

The sciences have become, in many ways, more complex. In many other ways, they have become less so. It is true that we live in a highly technical society—microwave ovens, high-speed communication systems, rapid transportation, and heart transplants. Yet, today's scientist is likely to work in one branch of a broader field of science. This has the effect of simplifying the scope of work of an individual scientist.

Despite the accelerating pace of science, especially in this century, there are still new technical frontiers to explore and new problems to solve, such as finding a cure for cancer and solving environmental problems. The need for scientists is at least as great as it has ever been. There is no reason to assume that the need can only be met by males. Women certainly can contribute to the sciences in the future and it would be a loss of available talent not to encourage young women to consider scientific careers. Those traits and abilities which are important in a scientist are the qualities of a good student, regardless of sex or race.

This CAREER GUIDE is designed to assist you in providing answers to questions which young people might ask about scientific careers. This information, written in everyday language, shows the relevance of the sciences to everyday life and shows the diversity of opportunities and scientific careers. Resources from which career information can be obtained, with an emphasis on those which will provide encouragement and awareness for young women, are also included.

Female role models, scarce in the past, are vital to career education for young women. They are equally vital to the young man who must change his perception of women in the sciences and who must learn to accept women in these roles. Supplemental to this CAREER GUIDE, the ROLE MODELS section of this packet can be used to provide further encouragement and awareness of the important contributions of women to the sciences. A number of biographies and autobiographies are listed in the RESOURCES section for in-depth study of the lives of women scientists.

*As we contemplate the future of science and technology, the debate currently being waged among scientists on public policy and ethics will result in some important decisions that will affect all human beings and their natural resources. These decisions will permeate many aspects of our private lives. It will be regrettable if half of our population has no voice in these matters. As one woman scientist** said:*

> *"I want to see women in the 'hard' sciences (physics, chemistry, mathematics) . . . Until such time, we will have little understanding, control, and participation in world decisions that affect our lives and that of our children."*

Hopefully, use of the information in this CAREER GUIDE will open doors to a greater decision-making role for women in the future.

Sharon L. Menard

**Much of the information on careers was derived from the OCCUPATIONAL OUTLOOK HANDBOOK, 1978. U.S. Department of Labor.*

***Sonia Gitlin, chemist*

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INTRODUCTION

"High intelligence alone does not make a youngster a scientist."

Paul F. Brandwein
THE GIFTED STUDENT AS FUTURE SCIENTIST
New York: Harcourt Brace, 1955

Traditionally, the world of science has included only those fields that deal with natural phenomena, such as physics, chemistry, and biology. Today, the social sciences, such as sociology and psychology, are included in the science grouping by organizations such as the American Association for the Advancement of Science. However, it is still in the traditional fields of science that women remain few. Of approximately two million scientists in the United States in 1974, about 9.4% were women. Few women ventured into these areas partially due to tradition and partially due to a mythology which has grown up around science and scientists. This mythology regards science as masculine subjects and pursuits, although there are women scientists whose achievements cannot be ignored. Some of these women are listed in the ROLE MODELS section.

This CAREER GUIDE is designed with the high school counselor in mind, but it can be used by teachers and others who advise young women. Its intent is to make it possible for an advisor to assist young women in learning about physical, life, earth, and mathematical science careers; in understanding their interrelationships in both the scientific world and in the everyday world; in understanding the importance of science in everyday life; and in becoming aware of the advantages of pursuing further studies in mathematics and science.

Within the scientific areas, a number of branches or highly specialized fields exist. This CAREER GUIDE will not deal with these extensively because the young student will not be concerned with that degree of specialization for a number of years to come. However, enough is included to generate awareness of the diversity and number of possibilities that do exist. A student interested in a particular branch of science can explore it on their own with your assistance and with the resources listed in this GUIDE under CAREER INFORMATION.

The more general fields, and some selected specialities, are described along with training requirements and employment outlook. But before we examine these, let's address a more fundamental question: WHAT TRAITS ARE SIGNIFICANT IN THE DEVELOPMENT OF FUTURE SCIENTISTS?

According to Paul Brandwein, three factor clusters can be identified which he considers important in the development of a scientist:

1. GENETIC FACTORS — including general intelligence, numerical ability, verbal ability, neuromuscular control (manual dexterity and mechanical aptitude).
2. PREDISPOSING OR PSYCHOLOGICAL FACTORS — including:
    a. PERSISTENCE — willingness to spend time beyond the ordinary for a given task; willingness to withstand discomfort, such as long hours, fatigue, strain; willingness to face failure.
    b. QUESTING (curiosity) — displaying a notable dissatisfaction with present explanations of the way that the world works. (This may imply that authority will not be accepted without question, or at least, not without ascertaining the reliability and validity of the authority.)
3. ACTIVATING FACTORS—including the opportunities offered in school and the special skills of teachers.

All of these factors are necessary to a scientist's development, believes Brandwein. Not one is sufficient in itself and not one is unique to either sex. The latter two factors are within the range and responsibility of the educator. This CAREER GUIDE will provide assistance to the educator in developing these factors in young women.

Hopefully, it will provide motivation for a special effort to encourage young women to consider scientific careers.

As a clarifying model, a "circle of science" (see figure 1) is useful. In the center of the circle is mathematics, the language of science. It is also a science in itself. Mathematics is required for any scientific career. But even if students do not plan to pursue technical fields, they may find that they will be at a disadvantage in the job market or in a college program if they do not study mathematics. This will prove particularly true if students find their college programs delayed because of mathematical deficiencies. These deficiencies must be made up at the college level before students' college programs can proceed, increasing the cost of college education.

Many college degree programs in nontechnical fields require more than two years of high school mathematics. Among these are:

Business
Dental Hygiene
Economics
Elementary Education
Geography
Nursery
Physical Education
Psychology

In many occupations which do not require college training, mathematics is also essential. Shop math, for example, is part of the apprenticeship training for many skilled trades.

Mathematics has always been basic to the natural sciences and engineering, but its importance to the social sciences and business has grown remarkably in recent years. Store owners used to guess at the amount of inventory to keep on hand for profitable results. Now they hire operations research specialists to determine this mathematically. Factories, which formerly inspected every item coming off the assembly line, now use statistical quality control methods to save time and money. The following list* shows the amount of mathematics necessary for adequate preparation to enter the scientific fields listed:

FIELD	NUMBER OF YEARS OF HIGH SCHOOL MATHEMATICS
Astronomy	4
Chemistry	4
Engineering	4
Entomology	3
Environmental Sciences	4
Food Sciences	3
Forestry	3
Genetics	4
Geology	3
Life Sciences	4
Mathematical Sciences	4
Pharmacy	4
Physics	4
Plant Pathology	3
Pre-Medicine	4

Three years of high school mathematics means: Algebra (2 years) and geometry (1 year). For four years of high school mathematics, an additional year of pre-calculus mathematics, including trigonometry, is advisable. The importance of a solid foundation in mathematics cannot be overemphasized.

In addition to the career descriptions in the GUIDE, personality traits are included in general terms. To gain further insight into specific traits of individual scientists, the ROLE MODELS section of this packet will be helpful. Salary and job outlook follow the descriptions.

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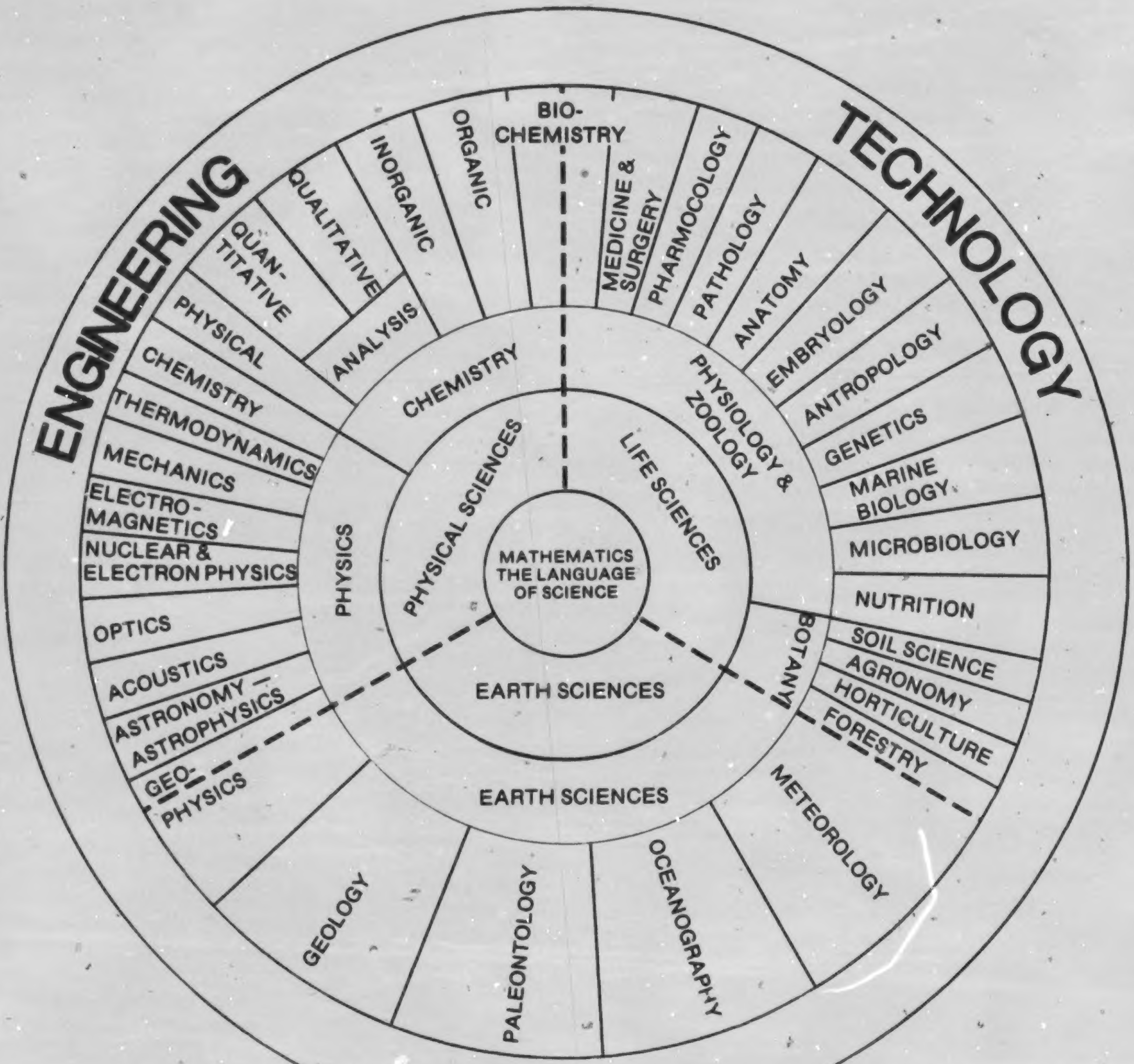
*THE MATH IN HIGH SCHOOL . . . YOU'LL NEED FOR COLLEGE
Brochure of The Mathematical Association of America.

FIGURE 1.
CIRCLE OF SCIENCE



Inner circle — Mathematics
Second circle — Major science groupings
Third circle — College majors
Fourth circle — Branches of science and specific course work
Outer circle — Applied sciences

MATHEMATICAL CAREERS

THE WORK

Mathematics is both a science and the language of science. It is a tool which is essential to many types of work. As a tool, mathematics provides a way to understand and express ideas in science, engineering, and increasingly, in human affairs. The application of mathematical techniques in these fields has increased greatly because of the extensive use of computers which permit complex problems to be solved rapidly and efficiently. Because of these trends, employment opportunities for persons trained in mathematics have expanded rapidly in recent years.

Mathematicians today are engaged in a wide variety of activities, ranging from creating new theories to translating scientific and managerial problems into mathematical terms. There are two broad classes of mathematical work: pure (theoretical) mathematics and applied mathematics, which includes solving numerical problems. Theoretical mathematicians develop new principles and new relationships between existing principles of mathematics. They are interested in expanding basic knowledge; practical application is not the prime consideration. This theoretical knowledge, however, has led to many useful scientific and engineering achievements.

Mathematicians in applied work develop theories, techniques, and approaches to problems in natural science, social science, management, and engineering. The problems range from analysis of space vehicle systems' reliability to studies of the effects of new drugs. Some specific fields of work for mathematicians include:

ACTUARIAL SCIENCE

This is the mathematics of physics-oriented problems, and, increasingly, economics and business, analyzing the frequency of chance and hazardous occurrences, forecasting the probability of recurrences, and recommending the price of insurance against these risks.

COMPUTER SCIENCE

This is the mathematics of translation, in other words, how to say "hello" to a computer. The mathematician communicates with computers, translating problem solutions and operations into a format which guides the computer operations.

CLASSICAL APPLIED MATHEMATICS

This is the mathematics of physics-oriented problems, and increasingly, economic and sociological systems. The mathematician analyzes data and constructs models of engineering, physical, or social problems.

OPERATIONS RESEARCH

This is the mathematics of decision making. The mathematician constructs simple mathematical models of complex business and economic structures which are used to aid in the prediction of future needs.

STATISTICS

This is the mathematics of large numbers. The mathematician analyzes and uses data, such as censuses of population, sales, production, inventories, and other business and industrial data. He or she might also aid in managerial decision making by designing sample surveys to determine the prospects of a business success.

THE PEOPLE

About 40,000 persons worked as mathematicians in 1974, including about 20 percent women. Out of 24,000 statisticians, one-third were women.

Young people considering careers in mathematics should be able to concentrate for long periods of time, should enjoy working independently with ideas and solving problems, and must be able to present their findings in written reports. They need good reasoning ability, persistence, and the ability to apply basic principles to new types of problems. They must be able to communicate well with others since they often must work with non-mathematicians on problem descriptions.

These traits are just as likely to be found in young women as in young men. The difference may actually come when a young woman thinks about how she can use the traits. For instance, the ability to communicate well might lead her to think she should be a teacher. It is important to encourage her to keep her options open by letting her know that these skills are useful to a mathematician as well.

THE TRAINING

Although advanced degrees are required for an increasing number of jobs, the bachelor's degree is still adequate preparation for many positions in private industry and the federal government. New graduates generally assist senior mathematicians with computations and with the solution of less advanced research problems.

Course work usually includes analytical geometry, calculus, differential equations, probability and statistics, mathematical analysis, and modern algebra. A prospective student should take as many mathematics courses as possible while in high school. This is especially important for the young woman to know. Point out to her the importance of a good mathematical foundation. Let her know that research evidence shows that the ability to learn mathematics is not sex-related.

If the student is interested in applied mathematics, training in the field in which the mathematics will be used is very important. Depending on the student's interest, the student should study physics, engineering, operations research, business, industrial management, economics, statistics, chemistry, life sciences, or the behavioral sciences. Training in numerical analysis and programming is especially desirable for mathematicians working with computers.

PHYSICAL SCIENCE CAREERS

Physical scientists work with basic scientific principles. They do basic research to expand knowledge of the properties of matter and energy. Some do both basic and applied research and others develop new products and processes. Specific fields in the physical sciences include the following.

ASTRONOMY

THE WORK

Astronomers seek answers to questions about the fundamental nature of the universe such as its origin and history and the evolution of our solar system. They use the principles of physics and mathematics to study and determine the behavior of matter and energy in distant galaxies. The information which is collected may help to prove or disprove theories of the nature of matter and energy, such as Einstein's Theory of Relativity.

To make observations of the universe, astronomers use a variety of tools, such as large telescopes, radio telescopes, spectroscopes to analyze light from stars and determine their chemical composition, and other instruments which can detect electromagnetic radiation from distant sources. Electronic computers are used to solve complex mathematical equations representing various theories, to calculate orbits of asteroids and the paths of comets, to guide spacecraft, and to work out tables for navigational handbooks.

Today's astronomers spend little time visually observing stars through telescopes because photographic and electronic light-detecting equipment is more effective with dim or distant stars and galaxies. Astronomers may also design these optical measuring devices,which can be attached to the telescope. After these observations are completed, astronomers analyze the results and present their findings. As a matter of fact, increasingly more of the astronomer's time is spent analyzing the large quantities of data from photographs that the observatory facilities collect. Some astronomers concentrate on theoretical problems and seldom visit observatories. Instead, they formulate theories or mathematical models to explain observations. Such astronomers use the laws of physics to develop, for example, theoretical models of how stars change their nuclear energy sources.

THE PEOPLE

Astronomy is the smallest physical science in terms of numbers employed. Of the two thousand persons employed in 1976, seven percent were women.

Students interested in careers in astronomy should have imagination, inquisitiveness, perseverance, ability to concentrate on details, and the ability to work independently. Traits such as patience and attention to detail have often been considered female traits, usually for typing jobs and needlework. These same abilities could be applied to a science such as astronomy.

THE TRAINING

The usual requirement for a career in astronomy is a Ph.D. degree; however, jobs such as assistant in an observatory, planetarium, or large college or university laboratory are available for those with a bachelor's or master's degree.

Students planning to become astronomers can major in astronomy, physics, or in mathematics (with a physics minor). Course work should include physics, mathematics, chemistry, statistics, computer science, optics, and electronics. The student should study astronomy, astrophysics, and techniques and instruments used in astronomy, if these courses are available.

CHEMISTRY

THE WORK

Chemists examine substances and then find practical uses for these substances. They may develop new compounds such as rocket fuel, improve foods, and create clothing that is chemically treated to resist fire, soil, and wrinkles. They investigate the properties and composition of matter and the way that elements combine with each other. Chemists often specialize in a subfield of chemistry. Some of these fields are:

ANALYTICAL CHEMISTRY

Analytical chemists determine the structure, composition, and nature of substances, and develop new techniques. A famous example of the work of this type of chemist is the analysis of moon rocks by an international team of chemists.

BIOCHEMISTRY

Biochemists often consider themselves as both chemists and life scientists because they study the chemical behavior and chemical nature of living things. This work is vital to the understanding of the basic functions of living things, often leading to the discovery of the effects of substances such as food, hormones, and drugs on various organisms. Applications of biochemical methods and techniques are useful in areas such as medicine and agriculture. For example, biochemists seek cures for diseases or identify the nutrients necessary to maintain good health.

ORGANIC CHEMISTRY

Organic chemists originally studied the chemistry of living things, but this area has broadened to include all carbon compounds. Carbon, in combination with other elements, forms an enormous variety of substances. This work has resulted in modern commercial products such as plastics and other synthetics.

INORGANIC CHEMISTRY

Inorganic chemists study compounds other than carbon. They may develop, for example, materials to use in solid state electronic computers.

PHYSICAL CHEMISTRY

Physical chemists study energy transformations to find new and better energy sources.

THE PEOPLE

Nearly 150,000 persons worked as chemists in 1976. About one-fourth of those recently receiving advanced degrees have been women.

Students planning careers in chemistry should enjoy studying science and mathematics. They should like working with their hands, building scientific apparatus, and performing experiments. Perseverance, ability to concentrate on detail, and ability to work independently are essential traits. Other desirable traits are inquisitiveness and imagination. Good eyesight and eye-hand coordination are also very important.

The hardest part about convincing young women to consider chemistry may be in generating enjoyment of science and mathematics. Social conditioning which labels science and mathematics as male subjects works against this employment. One way that a teacher can overcome this mental block is by offering "kitchen chemistry." The book CUP AND SAUCER CHEMISTRY by Nathan Shalit, listed in the RESOURCES section, is an excellent basis for such a unit.

THE TRAINING

A bachelor's degree with a major in chemistry or a related discipline is adequate for many beginning jobs. A strong background in chemistry with good laboratory skills is essential. Required courses usually include analytical, inorganic, organic, and physical chemistry. Biochemists might major in biochemistry or in biology with a minor in chemistry.

PHYSICS

THE WORK

Through systematic observation and experimentation, physicists describe the structure of the universe and the interactions of matter and energy in mathematical terms. They may develop theories that describe the fundamental forces and laws of nature, such as gravity, electromagnetism, and nuclear interaction. The fundamentals of atomic structure and the forces between nucleons (nuclear dynamics) are two topics of their investigations. These studies can lead to many useful discoveries. The development of radiation therapy in cancer treatment, for instance, resulted from physicists' work in nuclear radiation. Other recent contributions of physicists are in electronics, improvements in communications, aerospace, nuclear energy, and medical instrumentation.

The equipment that physicists develop for their basic research can often be applied to other areas. For example, lasers (devices which amplify light and emit electromagnetic waves in a narrow, intense light beam) are utilized in surgery, microwave devices are used in ovens, and special measurement techniques and instruments can detect the kind and number of cells in blood or the amount of mercury or lead in foods.

Some engineering-oriented physicists do applied research and help develop new products. Practical application of physicists' knowledge of solid-state physics, for example, led to the development of transistors and microcircuits used in electronic equipment, ranging from hearing aids to missile guidance systems.

Most physicists specialize in one or more branches of physics: elementary-particle physics; nuclear physics; atomic, electron, and molecular physics; physics of condensed matter; optics, acoustics, and plasma physics; and the physics of fluids. Some specialize in a subdivision of one of these branches; for example, within solid-state physics, there are the branches of ceramics, crystallography, and semiconductors. Growing numbers of physicists are specializing in fields combining physics and a related science. Examples of these are astrophysics, biophysics, chemical physics, and geophysics.

THE PEOPLE

About 48,000 people worked as physicists in 1976; four percent of these were women. Students planning a career in physics should have inquisitive minds, mathematical ability, and imagination. They should be able to work independently.

THE TRAINING

A bachelor's degree does limit job possibilities. Graduate training in physics or a closely related field is almost essential for most entry-level jobs and for advancement. However, those having a bachelor's degree do qualify for some applied research and development jobs in private industry and in the Federal Government. Many with a bachelor's degree find jobs in other scientific fields and in engineering. The young physicist often begins his or her career in laboratory work.

LIFE SCIENCE CAREERS

THE WORK

Life scientists study all aspects of living organisms, especially the relationship of animals and plants to their environment. Many work in laboratories conducting basic research aimed at adding to our knowledge of living organisms. Knowledge gained from this research is applied in medicine, in agriculture to improve crop yields, and in environmental sciences to aid in the betterment of the natural environment. Life scientists must be familiar with research techniques and complex laboratory equipment such as electron microscopes. Knowledge of computers is often useful. Research also can take place in locations other than the laboratory. For example, a botanist may do research in the volcanic Alaskan valleys to attempt to determine the kind of plants that can grow there.

Some life scientists work as consultants to business firms or to government. Others write for technical publications or test and inspect foods, drugs, and other products. Some work in technical sales and services for industrial companies where they demonstrate the proper use of new chemicals or technical products.

Some scientists working in the life sciences are called simply biologists. The majority, however, are classified by the type of organism they study or by the specific activity performed. For example:

AGRONOMY

This branch of the life sciences is concerned with the mass development of plants. Agronomists seek to improve the quality and yield of crops by developing new growth methods and by controlling disease, pests, and weeds. They also analyze soils to determine ways to increase acreage yields and decrease soil erosion.

ANATOMY

Anatomists study the structure of organisms, from cell structure to the formation of tissues and organs. Many specialize in human anatomy. Research methods may entail dissections with the aid of an electron microscope.

BOTANY

Life scientist dealing primarily with plants are called botanists. Some study all aspects of plant life, while others work in specific areas such as identifying and classifying plants or studying the structure of plants and plant cells. Some botanists concentrate on the cause and cure of plant diseases.

ECOLOGY

Some life scientists apply their specialized knowledge to a number of areas. Ecologists, for example, study the mutual relationships among organisms and their environments. They are interested in the effects on organisms of environmental influences such as rainfall, temperature, and altitude. Ecologists may extract samples of plankton (microscopic plants and animals) from bodies of water to determine the effects of pollution and to measure the radioactive content of fish.

EMBRYOLOGY

Embryologists study the development of organisms from a fertilized egg through the hatching process or gestation period. They investigate the causes of healthy and abnormal development in organisms.

HORTICULTURE

Horticulturists work with orchards and garden plants such as fruit and nut trees, vegetables, and flowers. They seek to improve plant culture methods for the beautification of communities, homes, parks, and other areas as well as for increasing crop quality and yield.

MICROBIOLOGY

Life scientists who are called microbiologists investigate the growth and characteristics of microscopic organisms such as bacteria, viruses, and molds. They isolate the organisms and examine them under a microscope. Medical microbiologists are concerned with problems such as the relationship between bacteria and disease or the effect of antibiotics on bacteria. Other microbiologists may specialize in soil bacteriology (effect of microorganisms on soil fertility), virology (viruses), or immunology (mechanisms that fight infections).

NUTRITION

Nutritionists examine the bodily processes through which food is utilized and transformed into energy. They study the process by which vitamins, minerals, proteins, and other nutrients build and repair tissue.

PATHOLOGY

Pathologists specialize in the effects of diseases, parasites, and insects on human cells, tissues, and organs. Others may study genetic variations caused by drugs.

PHARMACOLOGY

Pharmacologists conduct tests on animals such as rats, guinea pigs, and monkeys to determine the effects of drugs and medicines.

ZOOLOGY

Zoologists concentrate on animal life — its origin, behavior, and life processes. Some conduct experimental studies with live animals and others examine dissected animals in laboratories. Zoologists are usually identified by the animal group studied, such as ornithologists (birds), entomologists (insects), and mammalogists (mammals). Animal husbandry specialists research the breeding, feeding, and diseases of domestic farm animals. Veterinarians study diseases and abnormal functioning in animals.

Biochemists and biological oceanographers can also be considered life scientists.

THE PEOPLE

Almost one-third of all life scientists are in research and development. An estimated 205,000 persons worked as life scientists in 1976. Almost 40,000 were agricultural scientists; about 100,000 were biological scientists; and another 65,000 were medical scientists. About one-fifth of all biological and agricultural scientists were women.

The ability to work independently as well as part of a team is an important trait. Prospective life scientists should be able to communicate their findings clearly and concisely both orally and in writing. Physical stamina is necessary for those interested in research in remote places.

Verbal skills have long been thought to be strong female traits. Because these traits are assets for a life scientist, this should be pointed out to young women. Working independently and physical stamina are essential, not only for life scientists, but also for the young housewife and mother, an important comparison to point out as well.

THE TRAINING

Young people seeking careers in the life sciences should obtain the broadest possible undergraduate background in biology and the other sciences. Courses in biology, chemistry, physics, and mathematics should be taken. Bachelor's degrees are adequate preparation for some starting positions such as testing and inspecting jobs. Bachelor-level students may also work as technicians in medical research. Graduate degrees are essential for advancement.

EARTH SCIENCE CAREERS

The earth scientist, often referred to today as the environmental scientist, helps to increase the knowledge of the earth's physical environment. This field plays an important role in solving environmental problems such as pollution. Scientists in these fields are concerned with the history, composition, and characteristics of the earth's surface, interior, and atmosphere. Some do basic research to increase scientific knowledge; others do applied research, using basic research knowledge to help solve practical problems. Geologists, for example, explore for new sources of oil, other fuels and ores. Meteorologists forecast the weather. The major earth science fields are:

GEOLOGY

THE WORK

Geologists study the structure, composition, and history of the earth's crust in order to locate natural resources, give warnings of natural disasters, and insure that buildings are constructed on adequate foundations. By examining surface rocks and drilling to recover rock cores, they determine the distribution, thickness, and slope of the rocks beneath the earth's surface. They also identify rocks and minerals, conduct geological surveys, draw maps, take measurements, and record data.

In field work geologists use tools and instruments such as hammers, chisels, levels, transits (mounted telescopes used to measure angles), gravity meters, cameras, compasses, and seismographs (instruments that record the intensity and duration of earthquakes and tremors).

Geologists may also work in laboratories where they examine the chemical and physical properties of earth specimens under controlled temperature and pressure; study fossil remains of animal and vegetable life; experiment with the flow of water and oil through rocks; evaluate information from photographs taken from aircraft and satellites; and use computers to record and analyze data. Laboratory equipment used by geologists includes complex instruments such as the X-ray diffractometer, which determines the structure of minerals, and the petrographic microscope for close study of rock formations.

In addition to field and laboratory work, geologists may advise construction companies and governmental agencies on the suitability of certain locations for construction of buildings, dams, or highways. Geologists usually specialize in one or a combination of three areas — earth materials, earth processes, and earth history. Some specialized geology areas are:

ECONOMIC GEOLOGY

These geologists locate earth materials such as minerals and solid fuels.

PETROLEUM GEOLOGY

These geologists search for and recover oil and natural gas. Some petroleum geologists work near drilling sites and others correlate petroleum-related geologic information for entire regions.

ENGINEERING GEOLOGY

These geologists locate sites which are suitable for constructing roads, airfields, tunnels, dams, and other structures by determining, for example, whether underground rocks will bear the weight of a building or whether a proposed structure may be in an earthquake-prone area.

GEOCHEMISTRY

Geochemists study the chemical composition and changes in minerals and rocks to understand the distribution and migration of elements in the earth's crust.

VOLCANOLOGY

These geologists study earth processes such as landforms and their rock masses, sedimentary deposits (matter deposited by water or wind) and eruptive forces such as volcanoes. Volcanologists study active and inactive volcanoes, lava flows, and other eruptive activities.

GEOMORPHOLOGY

Geomorphologists examine landforms and those forces, such as erosion and glaciation, which cause them to change.

PALEONTOLOGY

Some geologists are primarily concerned with the history of the earth. Paleontologists study plant and animal fossils to trace the evolution and development of past life.

GEOCHRONOLOGY

Also concerned with earth history, geochronologists determine the age of rocks and landforms by measuring the radioactive decay of their elements.

STRATIGRAPHY

Stratigraphers study the distribution and arrangement of sedimentary rock layers by examining their fossil and mineral content.

ASTROGEOLOGY

Astrogeologists study geological conditions on other planets.

GEOLOGICAL OCEANOGRAPHY

These geologists study the sedimentary and other rocks on the ocean floor and continental shelf.

THE PEOPLE

More than 34,000 geologists were employed in 1976; approximately ten percent of these were women. The traits required for this field are similar to other fields of science. In addition, students planning careers in exploration geology should enjoy the outdoors and must have physical stamina. Beginning careers are usually in field exploration or as laboratory research assistants.

THE TRAINING

A bachelor's degree in geology or a related field is adequate for entry into many geology jobs. Undergraduate students should devote about one-fourth of their time to courses in geology. Historical geology, structural geology, mineralogy, petrology, and invertebrate paleontology are some of these. About one-third of their course work should include mathematics and the related sciences of physics, chemistry, and engineering.

GEOPHYSICS

THE WORK

Geophysicists usually specialize in one of three phases of the science — solid earth, fluid earth, and upper atmosphere. Some may study other planets. Examples of careers in geophysics are:

SOLID EARTH GEOPHYSICS

These scientists search for oil and mineral deposits, map the earth's surface, and study earthquakes.

SEISMOLOGY

Seismologists study the earth's interior and earth vibrations caused by earthquakes and human-caused conditions such as explosions. They explore for oil and minerals, study underground detection of nuclear explosions, and provide information for use in constructing bridges, dams, and buildings. For example, seismologists use explosives to determine where the bedrock (solid rock beneath the soil) is closest to the surface so that dam site selection can be optimum. The time it takes for a shock or sound wave to return to the surface indicates the depth of bedrock.

EXPLORATION GEOPHYSICS

These geophysicists use seismic prospecting techniques (sending sound waves into the earth) to locate oil and mineral deposits. They record the echoes that bounce off the rock layers to determine if conditions are favorable for the accumulation of oil.

GEODESICS

Geodesists study the size, shape, and gravitational field of the earth and other planets. Their principal task is to map the earth's surface. With the aid of satellites, they determine the positions, elevations, and distances between points on the earth, and measure the intensity and direction of gravitational attraction.

HYDROLOGY

Hydrologists are concerned with the liquid part of the earth. They may study the distribution, circulation, and physical properties of underground and surface waters, including glaciers, snow, and permafrost. They may also study rainfall and its rate of infiltration into soil. Some are concerned with water supplies, irrigation, flood control, and soil erosion.

GEOMAGNETICS

Geomagneticians study the earth's magnetic field.

PALEOMAGNETICS

Paleomagneticians learn about past magnetic fields from rocks or lava flows.

PLANETOLOGY

Planetologists study the composition and atmosphere of the moon, planets, and other bodies in the solar system. They gather data from geophysical instruments carried by interplanetary space probes or from equipment used by astronauts in Apollo flights.

THE PEOPLE

About 12,000 people worked as geophysicists in 1976, mainly for petroleum and natural gas companies. The traits required for this field are comparable to those needed for geology and physics.

THE TRAINING

A bachelor's degree in geophysics or a geophysical speciality provides entry to most beginning geophysics jobs. A related field of science or engineering is also excellent preparation as long as courses in geophysics, physics, geology, mathematics, chemistry, and engineering are included. Beginning jobs usually include field mapping and exploration or assisting in a research laboratory.

METEOROLOGY

THE WORK

Meteorology is the study of the atmosphere (the air surrounding the earth). Meteorologists are sometimes classified as geophysical scientists. They describe and increase scientific knowledge of the atmosphere's physical composition, motions, and processes. They determine the effects of these elements on our physical environment. This knowledge is applied to forecasting weather, understanding climate, and solving practical problems in agriculture, transportation, communications, health, and national defense.

Meteorologists who specialize in forecasting the weather, known professionally as synoptic meteorologists, are the largest group of specialists. They study current weather information, such as air pressure, termperature, humidity, and wind velocity, in order to make short- and long-range predictions. Their data comes from weather satellites and observers in many parts of the world. Although some forecasters still prepare and analyze weather maps, most data now is plotted and analyzed by computers.

Other meteorologists apply their knowledge to the study of relationships of weather, specific human activities, biological processes, and agricultural and industrial operations. For example, they may make weather forecasts for individual companies or may work on problems such as smoke control and air pollution abatement. Meteorology, however, involves many activities other than weather forecasting. For example:

PHYSICAL METEOROLOGY

These scientists study the chemical and electrical properties of the atmosphere by doing research on atmospheric effects on transmission of light, sound, and radio waves. They study factors affecting formation of clouds, rain, snow, and other weather phenomena.

CLIMATOLOGY

Climatologists study trends by analyzing past climatic records of wind, rainfall, sunshine, and temperature to determine the general pattern of weather that makes up an area's climate. These studies are useful for designing buildings and are an aid in effective land utilization.

THE PEOPLE

About 5500 persons — ten percent women — were employed as meteorologists in 1976. The largest employer of meterologists is the Federal Government.

The ability to concentrate on details, patience, and persistence are important traits for meteorologists. They are also commonly thought to be female traits.

THE TRAINING

The usual minimum requirement for starting positions in weather forecasting is a bachelor's degree in meteorology, although a degree in a related science or engineering field with at least 20 semester hours in meteorology is acceptable for some jobs. Training should also include physics and calculus.

OCEANOGRAPHY

THE WORK

Oceans cover more than two-thirds of the earth's surface and are very important to Spaceship Earth. Oceans provide people with valuable food, fossil fuels, and minerals; they influence the weather; they serve as a "highway" for transportation; and they offer many kinds of recreation. Oceanographers study and increase our knowledge of the oceans by using principles and techniques of natural science, mathematics, and engineering to examine the movements, physical properties, and plant and animal life of the oceans. Their research not only extends basic scientific knowledge, but also helps develop practical methods for forecasting weather, developing fisheries, mining ocean resources, and improving national defense.

The work of an oceanographer may include making tests and observations; conducting experiments from ships or stationary platforms at sea; studying and collecting data on ocean tides, currents, and other phenomena; and studying undersea mountain ranges and valleys, oceanic interaction with the atmosphere, and layers of sediment on and beneath the ocean floor.

Oceanographers also work in laboratories on land where they dissect and photograph fish, study exotic sea specimens and plankton (floating microscopic plants and animals), catalog and analyze different kinds of sea life and minerals, and plot maps. They may also use computers to test theories about the ocean. To present the results of their studies, oceanographers prepare charts, tabulations, and reports, and write papers for scientific journals.

In their work oceanographers travel by aircraft, surface ships, and various types of underwater craft. They use specialized instruments to measure and record the findings of their explorations and studies. Special cameras equipped with strong lights are used to photograph marine life and the ocean floor, and sounding devices are used to measure, map, and locate ocean materials.

Most oceanographers specialize in one branch of the science:

BIOLOGICAL OCEANOGRAPHY

These are marine biologists who study plant and animal life in the ocean. They search for ways to extract drugs from marine plants or animals, investigate life processes of marine animals, and determine the effects of radioactivity and pollution on marine life.

PHYSICAL OCEANOGRAPHY

These oceanographers are physicists and geophysicists who study the physical properties of the ocean. This research on the relationships between the sea and the atmosphere may lead to more accurate weather prediction.

GEOLOGICAL OCEANOGRAPHY

These oceanographers are marine geologists who study the ocean's mountain ranges, rocks, and sediments. Location of minerals, oil, and gas under the ocean floor is one application of their work.

CHEMICAL OCEANOGRAPHY

Scientists in this field investigate the chemical composition of ocean water and sediments as well as chemical reactions in the sea.

OCEANOGRAPHIC ENGINEERING

Oceanographic engineers and electronic specialists design and build instruments for oceanographic research and operations. They also lay cables and supervise underwater construction.

THE PEOPLE

The interdisciplinary nature of oceanography requires that these scientists have most of the traits needed for science in general. Because the work involves the ocean, the jobs will be found at ocean locations.

THE TRAINING

Since oceanography is an interdisciplinary science, an undergraduate major in basic science with a strong interest in oceanography would be good preparation for beginning jobs. The student may major in oceanography or marine science, but a major in biology, earth or physical sciences, mathematics, or engineering may work just as well.

Important college courses include mathematics, physics, chemistry, geophysics, geology, meteorology, and biology. Most oceanographers begin as research or laboratory assistants or in jobs involving routine data collection, computation, and analysis.

ENGINEERING CAREERS

THE WORK

The work of engineers is quite extensive and, as a result, affects our lives in many different ways. For example, engineers develop and design power plants and water supply and waste disposal systems to meet the problems of urban living. They also design machines and artificial organs; industrial machinery and equipment used to manufacture goods; heating, air-conditioning, and ventilation equipment for more comfortable living; scientific equipment to probe outer space and the ocean depths; consumer products such as automobiles and refrigerators; and systems for the control and automation of manufacturing, business, and management processes. They also design, plan, and supervise the construction of buildings, highways, and rapid transit systems.

In developing a new product, engineers first determine the general nature of the device, calculate and test all components, and put them together in an integrated plan. Following this, they evaluate the overall effectiveness of the new device as well as its cost and reliability. The same steps are applied to most products, whether they are artificial hearts, electronic computers, or industrial machinery.

Most engineers specialize in one of the more than 25 specialities recognized by professional societies. These specialities further divide into 85 subdivisions. For example, structural, environmental, hydraulic, and highway engineering are subdivisions of civil engineering. Engineers may also specialize in the problems of one industry, such as motor vehicles, or in a particular field of technology, such as propulsion or guidance systems. Since knowledge of basic engineering principles is required for all areas of engineering, shifting from one branch or field of specialization to another is possible, especially during the early stages of an engineering career. Some of the engineering branches are:

AEROSPACE ENGINEERING

Aerospace engineers play a vital role in America's defense and space activities. They plan, design, develop, and test aerospace products including missiles, rockets, and military and commercial planes. They generally work in specialities such as structural design, navigational guidance and control, instrumentation and communication, or production methods. Or, they may specialize in one type of aerospace product such as passenger planes, launch vehicles, satellites, manned space capsules, or landing modules.

AGRICULTURAL ENGINEERING

Agricultural engineers develop machinery, equipment, and methods to improve efficiency in the production, processing, and distribution of food and other agricultural products. They design farm machinery, equipment, and structures, and develop methods for utilizing electrical energy on farms and in food and feed processing plants. Agricultural engineers also are concerned with conservation and management of soil and water resources.

BIOMEDICAL ENGINEERING

Biomedical engineers use engineering principles to solve medical and health related problems. Many do joint research with life scientists, chemists, and members of the medical profession on the engineering aspects of the biological systems of man and animals. Some design and develop medical instruments and devices including artificial hearts and kidneys, lasers for surgery, and pacemakers that regulate the heartbeat. Other biomedical engineers adapt computers to medical science and design and build systems to modernize laboratory, hospital, and clinical procedures. Most engineers in this field require a sound background in one of the major engineering disciplines — mechanical, electrical, or chemical — in addition to specialized biomedical training.

CERAMIC ENGINEERING

Ceramic engineers develop methods for processing ceramic materials into useful products. Although the word ceramics usually means pottery, ceramics include all non-metallic, inorganic materials which require the use of high temperature in their processing. Thus, ceramic engineers may work on diverse products such as glassware, heat-resistant materials for missile nose cones, electronic components and materials used in medical devices, and nuclear reactors. They generally specialize in one or more of these products, for example, products of refractories (fire-resistant materials such as firebrick); whitewares (porcelain and china dinnerware or high-voltage electrical insulators), structural materials (such as brick, tile, and terra cotta), electronic ceramics (ferrites for computer memory systems and microwave devices), glass, abrasives, cement technology, or fuel elements for atomic energy.

CHEMICAL ENGINEERING

Chemical engineers are involved in many phases of the production of chemicals and chemical products. They design equipment and chemical plants as well as determine methods of manufacturing the product. Often they design and operate pilot plants to test their work and develop chemical processes such as those for removing chemical contaminants from waste materials. Because the work of chemical engineering cuts across many fields, these engineers must have a working knowledge of chemistry, physics, and mechanical and electrical engineering. This branch of engineering is so diverse and complex that chemical engineers frequently specialize in a particular chemical process, such as oxidation (reaction of a substance with oxygen) or polymerization (union of small molecules to form larger ones). Or, they specialize in a particular area such as environmental control or in the production of a specific substance such as plastics or rubber.

CIVIL ENGINEERING

Civil engineering is one of the oldest branches of engineering. Major specialities within civil engineering are structural, hydraulic, environmental (sanitary), transportation, (including highways and railways), geotechnical and soil mechanics, ocean (mineral recovery and transportation), and urban planning. Civil engineers design and supervise the construction of roads, harbors, airports, tunnels, bridges, water supply and sewage systems, and buildings.

ELECTRICAL ENGINEERING

Electrical engineers design, develop, and supervise the manufacture of electrical and electronic equipment such as electric motors and generators, communications equipment, heart pacemakers, pollution-measuring instruments, radar, computers, lasers, missile guidance systems, and electrical appliances of all kinds. They also design and operate facilities for electric power generation. Electric engineers specialize in a major area of work such as electronic computers, electrical equipment manufacturing, communications, or power. Exampies of further specialization within these broad areas are microwaves or missile guidance and tracking systems.

INDUSTRIAL ENGINEERING

Industrial engineers determine the most effective ways of organizing the basic factors of production — personnel, machines, and materials. They are more concerned with people and methods of business organization than other branches of engineering. Industrial engineers design systems for data processing, apply operations research techniques to organizational and production problems, develop management control systems to aid in financial planning and cost analysis, design product control systems, improve systems for physical distribution of goods and services, survey sites for industrial plants, and develop wage and salary administration concepts and job evaluation programs.

MECHANICAL ENGINEERING

Mechanical engineers are concerned with the production, transmission, and use of power, including internal combusion engines, steam and gas turbines, jet and rocket engines, and nuclear reactors. They also design and develop many machines that use power such as refrigeration and air-conditioning equipment, elevators, machine tools, printing presses, steel-rolling mills, and others. Because these engineers have been employed in nearly all industries, many specialized areas of work have developed. Motor vehicles, marine equipment, steam power, heating and air-conditioning equipment, instrumentation, and machines for specialized industries such as petroleum, rubber and plastics, and construction are some of the specialities.

METALLURGICAL ENGINEERING

Metallurgical engineers, increasingly referred to as materials engineers, develop methods to process and convert metals into useful products. These engineers generally work in one of the three main branches of metallurgy — extractive or chemical, physical, and mechanical. Extractive metallurgists are concerned with extracting metals from ores and refining and alloying them to obtain useful metals. Physical metallurgists deal with the nature, structure, and physical properties of metals being made into final products. Mechanical metallurgists develop methods such as casting, forging, rolling, and drawing to work and shape metals.

MINING ENGINEERING

Mining engineers locate, extract, and prepare minerals for manufacturing industries. They design the layouts of mines, supervise the construction of mine shafts and tunnels in underground operations, and devise methods for transporting minerals to processing plants. Mining engineers are responsible for the efficient operation of mines and for mine safety. Some mining engineers work with geologists and metallurgical engineers to locate and appraise new ore deposits. Others develop new mining equipment and devise improved methods to process extracted minerals. Mining engineers frequently specialize in the extraction of specific minerals such as coal or iron. With increased emphasis on protecting the environment, many mining engineers have been working on problem solutions related to mined-land reclamation.

PETROLEUM ENGINEERING

The work of petroleum engineers mainly involves drilling for and producing oil and gas with the best and most efficient drilling methods. Petroleum engineering research and development of these optimum methods may increase the proportion of oil recovered. This is an important contribution to increasing our available energy resources.

THE PEOPLE

In 1976, more than 1.1 million persons were employed as engineers, making it, after teachers, the second largest professional occupation. But unlike teaching,which is predominately a woman's field, only one percent of all engineers are women. The number of women engineers is expected to increase in the future since enrollments of women in engineering programs have increased sharply in the past few years due to special efforts on the part of engineering organizations and schools to encourage women and minorities to enter engineering professions.

Students who are interested in engineering should be able to work as part of a team, should have minds which are both creative and analytical, and should be capable of working with details. They will need to express their ideas well, both orally and in writing.

Because engineering often raises an image of heavy machines and heavy work (road building and bridge building are part of the oldest branch of engineering), it is considered a male profession. But, as can be seen from the engineering career descriptions, there is considerable variety in engineering work and a large part of it takes place in office buildings.

The desirable traits of an engineer, such as ability to work as part of a team, ability to express ideas orally and in writing, and capacity for handling details, are often cited as desirable traits for clerical workers or assembly line workers. With guidance and motivation, young women could use these skills in engineering fields.

THE TRAINING

A bachelor's degree in engineering is the usual educational requirement for beginning engineering jobs, although college graduates trained in one of the natural sciences or mathematics also may qualify for some beginning jobs. Admission requirements for undergraduate engineering schools include high school courses in advanced mathematics and the physical sciences.

In a typical four-year curriculum, the first two years are spent studying the basic sciences of mathematics, physics, chemistry, introductory engineering, the humanities, the social sciences, and English. The last two years are usually devoted to specialized engineering courses.

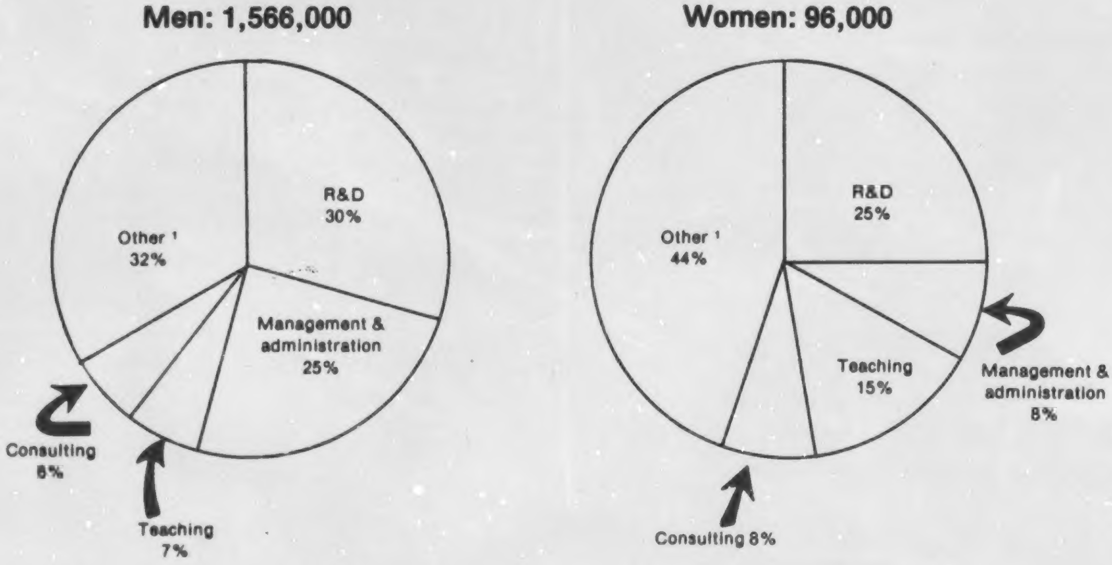
Since some engineering curricula require more than four years to complete, a number of colleges and universities now offer a five-year master's degree program. In these programs, the engineering schools combine with liberal arts colleges so that the student spends three years studying liberal arts and two years studying engineering.

Some schools have five- or six-year cooperative plans in which students coordinate classroom study with practical work experience. Such plans enable students to help finance their education while gaining useful, practical experience.

OTHER SCIENTIFIC CAREERS

In addition to the many diverse kinds of work described so far, there are mathematicians, scientists, and engineers who teach. Some of these people teach in secondary schools; a large number, particularly in fields such as physics, mathematics, and astronomy, teach in institutions of higher education. Three-fourths of all mathematicians work in colleges and universities. Other types of technical work that require less training include technical management and technical sales. (See Figure 2 below.)

Figure 2.
Scientists and engineers by sex and primary work activity: 1974



[1] includes production/inspection, computing, all other activities, and no report.
SOURCE: National Science Foundation, Manpower Characteristics System.

There are also scientific careers which draw on several disciplines and which are directly applicable to everyday living. Some of these are:

FOOD SCIENCE

THE WORK

In the past, most food was processed in the home. Today, industry processes almost all foods. A key worker is the food scientist or food technologist. Food scientists investigate the chemical, physical, and biological nature of food and apply this knowledge to processing, preserving, packaging, distributing, and storing food.

Specific work of the food scientist includes studying the structure and composition of food and the changes it undergoes in storage and processing, creating new foods, developing new processing methods, improving existing foods, and conducting chemical and microbiological tests to assure that food products meet industry and governmental standards.

THE PEOPLE

In 1976, seven thousand persons were employed in food science. Ten percent of them were women.

People planning careers as food scientists should have analytical minds and like detailed, technical work. They must be able to express their ideas clearly to others. Working with food is work that has been traditionally associated with women, not however, in a money-making capacity. Opportunities are good if young women can be encouraged to broaden their thinking beyond the home economics courses to include the mathematics and science courses which would open the doors to better paying careers as food scientists.

THE TRAINING

A bachelor's degree with a major in food science or in one of the physical or life sciences is needed for entry in the food science field. Undergraduate students majoring in food science usually take courses in physics, chemistry, mathematics, biology, the social sciences, the humanities, and business administration. Specific food science courses include areas such as preservation, processing, sanitation, and food marketing.

SOIL SCIENCE

THE WORK

Soil scientists study the physical, chemical, and biological characteristics and behavior of soils. They investigate soils both in the field and in the laboratory and classify them according to a national system of soil classification. This aids in determining the soil capability for crops, grasses, and tree production and its suitability for foundations of buildings and other structures.

Soil scientists prepare maps indicating different kinds of soils, conduct research on physical and chemical properties to understand their behavior and origin, and predict the yield of cultivated crops, grasses, and trees when alternative soil management practices are used.

Opportunities in soil science include specialities such as soil classification and mapping, soil geography, soil chemistry, soil physics, soil microbiology, and soil management.

THE PEOPLE

In addition to demonstrating the traits that are important for physical scientists, soil scientists are often expected to write reports about their work. Therefore, well-developed writing skills are especially important for the soil scientist.

THE TRAINING

A bachelor's degree is a minimum requirement with a major in soil science or a closely-related field of study with 30 semester hours in life, physical, and earth sciences, including a minimum of 12 semester hours in soils. A major in agriculture may also qualify. Course work in chemistry and map-making is also desirable.

TECHNICAL CAREERS WITHOUT A COLLEGE DEGREE

Up to this point, the careers described have required college training. This is a likely route for the person interested in science, but it is not the only possibility. There are careers which require some other form of technical training. Opportunities of this type are expanding to such an extent that, of the jobs to be filled into the 1980's, 80 percent will not require a college degree. Examples of these are drafters, engineering and science technicians, broadcast technicians, surveyors, medical and dental assistants, laboratory technicians, diesel mechanics, technical writers, and insurance agents.

Training is often available within the regular high school curriculum or some form of post-secondary training is necessary. Technicians assist various scientific professionals. To give a particular example of a technical career without a college degree, let's look at the career of electronic service technician.

We live in an age of electronics — radio, television, and recordings. Current estimates indicate there is an immediate need for an additional 20,000 electronic service technicians. The U.S. Department of Labor estimates that the number of these technicians is increasing at a rate of two percent per year while the number of consumer electronic products is increasing at an average rate of 20 percent per year. The regular high school curriculum may provide training, but due to traditional assumptions about appropriate jobs for men and women, young women have seldom considered these challenging, lucrative jobs. Women need to become aware of the possibilities early in their secondary education because some form of specialized training — vocational school, on-the-job training, apprenticeship programs, or correspondence schools — is needed. In the case of on-the-job training or apprenticeships, the career educator can help by doing community career exploration and setting up training arrangements in the community. (See CAREER ACTIVITIES in this CAREER GUIDE.) Employment is available in almost every community.

The student interested in an electronic service career should have an inquiring, logical mind, orderly work habits, and the ability to express him- or herself effectively. To supplement the student's formal training he or she should be encouraged to join a science or radio club and to develop electronic kit building or amateur radio hobbies.

SALARIES

If scientific and technical jobs sound interesting, the salaries will be of interest also. Most scientific and technical occupations pay well. The salaries of scientists, on the average, are twice the average for most nonsupervisory workers in private industry. Certainly these salaries are far better than the salaries for most clerical positions that women tend to enter. In addition, most of these jobs can lead to other opportunities. Examples of starting salaries in 1976 may be seen in Table I and Table II.

Table I. Starting salaries in 1976 for selected scientific fields*

FIELD	STARTING SALARIES (per annum)
Drafter	$ 8,400
Engineer	
aerospace	$14,268
chemical	$16,212
civil	$13,764
electrical	$14,448
industrial	$14,568
mechanical	$14,964
metallurgical	$15,600
Engineering & Science Technician (no college training)	$ 6,572
Food Scientist	$11,300
Geologist	$13,300
Life Scientist	$10,900
Mathematician	$11,500

Compare the salaries in Table I with the starting salaries in other fields in Table II.

Table II. Starting salaries in 1976 for selected non-scientific fields*

FIELD	STARTING SALARIES (per annum)
Nursing	$11,820
Office occupations	$ 5,876
Social Sciences	$10,000
Social Workers	$ 9,500
Teaching (for 9 month period)	
elementary	$ 8,233
secondary	$12,395
college	$ 7,272

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*Source: OCCUPATIONAL OUTLOOK HANDBOOK, 1978. U.S. Department of Labor.

JOB OUTLOOK

Generally speaking, the job opportunities for scientific and technical workers are quite good. In some specific technical fields the job opportunities may be better than in others. For example, employment opportunities for engineers are expected to increase faster than the average for all occupations because of the demand for goods and services. Mathematicians may find that there are fewer job openings than the number of people seeking employment, but jobs will be available in related fields, such as statistics, actuarial work, computer programming, systems analysis, economics, engineering, and the physical and life sciences. It is important for the aspiring young mathematician to consider combining mathematics with some other field to enlarge his or her career options.

Job prospects in the earth sciences will be good. The demand for geologists, for example, is expected to rise as consumer demand for petroleum and minerals rises and efforts are made to increase the energy supply from domestic sources.

In the life sciences, job demand is expected to grow faster than the average for all occupations. In actual numbers and, by way of comparison, the projected annual job openings into the 1980's are listed in Table III.

Table III. Annual job openings in selected fields*

POSITION	AVERAGE ANNUAL OPENINGS
Accountant	1,100
Chemist	9,400
Civil Engineer	10,000
Computer Programmer	34,700
Dietitian	2,300
Drafter	16,300
Electrical Engineer	10,000
Employment Counselor	1,100
Engineering & Science Technician	33,000
Life Scientist	9,900
Mathematician	4,600
Occupational Therapist	1,600
Physician	22,000
Physicist	3,500
System Analyst	22,700

Job opportunities for young women can be measurably increased if they are willing to try the scientific and technical occupations. The jobs are diverse and the salaries, job outlook, and chances for advancement are good. To not include these possibilities in their career options is to significantly reduce their share of the job market. Young women need the information in this CAREER GUIDE, but they also need support and encouragement to enter fields where women have numbered so few.

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*Source: OCCUPATIONAL OUTLOOK HANDBOOK, 1978. U.S. Department of Labor.

A CHECKLIST

CREATING A SUPPORTIVE ENVIRONMENT FOR GIRLS IN SCIENCE

Sometimes it is difficult to establish the attitudinal and environmental reasons for the low interest and participation of girls in mathematics and science. Certain factors and activities are known influences. This checklist will aid educators in identifying influential factors and, along with the STUDENT CHECKLIST, CAREER ACTIVITIES, and CAREER INFORMATION in this GUIDE, will suggest ways to increase the interest and participation of girls in scientific courses.

1. Have girls been identified who display competence in mathematics or science? who are inquisitive? who are persistent? who have analytical abilities? who display organizational skills? The STUDENT CHECKLIST included in this CAREER GUIDE can be helpful in this identification process.
2. Have reasons been solicited for why girls like or dislike science or mathematics courses? Has the same been done for the male student? Upon comparing their reasons, is there a difference? Why?
3. Have the male and female registration figures in required science and mathematics courses been compared to those which are not required, particularly the advanced or "honors" courses? Are the figures similar? Are they different? By how much? Why?
4. Is there evidence that girls are being counseled away from science and mathematics courses? Where is it happening? Why is it happening? What can be done about it? If this is happening, see items 7-13 of this checklist and CAREER ACTIVITIES for suggestions to change the situation.
5. Has a career interest survey been done? How many students indicated an interest in scientific and technical careers? How many male students are interested? How many female students are interested? Of the males and females who indicated an interest, do 20 percent or less of one sex indicate an interest? Which sex? If so, find out why.
6. Has career information in the sciences been obtained? Is the scientific and technical career information well-represented in the school career information? Is it accessible to the students? In the scientific career information, are both males and females represented in a balanced fashion? If women are underrepresented, obtain career information listed in this GUIDE.
7. Are girls taking industrial arts, drafting, repair, and photography courses? It is important to encourage them, because these are foundation skills for the applied sciences. For ways to encourage girls, see items 8-11 of this checklist and CAREER ACTIVITIES for suggestions.
8. Have girls been actively recruited to take mathematics, science, and industrial arts courses? In what ways? What ways can girls be encouraged to take these courses? Some of the career activities included in this CAREER GUIDE may be helpful. Also some of the skill activities in the CURRICULUM section will motivate and encourage girls to try these courses.
9. Have teachers of the science, mathematics, and industrial arts courses talked to girls about these courses in the rooms where they are offered with hands-on demonstrations?
10. In scheduling classes, are elective science and mathematics courses scheduled so there is no conflict with other courses girls are likely to take?
11. Have plans been made for science career days, including a WOMEN IN SCIENCE workshop? Ways to organize a WOMEN IN SCIENCE workshop are included in the CAREER ACTIVITIES part of this CAREER GUIDE.
12. Has a WOMAN SCIENTIST BUDDY SYSTEM been arranged? See the CAREER ACTIVITIES included in this CAREER GUIDE.
14. Has a career activity list, as part of career exploration, been generated? For ways to do this, see the CAREER ACTIVITIES in this CAREER GUIDE.
15. In conjunction with the career activity list, have visitations to the site of the career activity taken place? Have community people been recruited to participate in your school's career education as career advisors?

16. Has a summer jobs program been developed in which girls might serve as assistants in scientific work? This is where the career activity list and recruitment of community people will be beneficial.
17. Have meetings been held with the parents of girls who are interested in the sciences? See CAREER ACTIVITIES in this CAREER GUIDE for ways to involve parents.
18. Have scientific career course sequences been developed, including vocational education, which might relate to science and technical interests? These should outline course requirements and the order in which courses should be taken. The information in this CAREER GUIDE and college catalogs will be helpful in doing this. Discuss educational opportunities, financial aid, and jobs with students.

CAREER ACTIVITIES

WOMEN IN SCIENCE WORKSHOP

Often the fact that women have made contributions to the sciences comes as a surprise to young people, especially if they have had little opportunity to talk to scientists or engineers about their work. A mystique has built up around scientists which tends to obscure what scientists do and what they are like as persons. This is even more true of women in science because of their small numbers, and because science and mathematics are not regarded as "female subjects". Holding a workshop with women scientists is a technique for dispelling myths and misunderstandings which may exist in the minds of young women.

Invite women scientists, mathematicians, and engineers to talk to students. Be sure to invite both those who are currently active in their fields and those who have worked in scientific fields in the past.

Involve parents, parent groups, and other community groups in the planning and organization of the workshop. Also try to have representatives from various laboratories, colleges, and industries participate in the planning. Have these representatives talk about the work of scientists in their organizations or provide displays during the workshops.

Arrange for displays, films, tapes, etc. on women in science. Provide career information in the form of brochures and booklets on women in science. Resource materials are listed in this CAREER GUIDE and in the RESOURCES section of this packet.

Arrange with the librarian in your school or in the public library for a display of books about women scientists. Have women scientists talk during the workshop both formally and informally in large and small groups. Some topics of interest might be:

DAY-TO-DAY ACTIVITIES
(including both the physical and human environment)

JOB DEMANDS
(including both satisfactions and frustrations)

TRAINING REQUIREMENTS

ENCOURAGEMENT AND OBSTACLES ENCOUNTERED

PERSONAL LIFE
(including life style and relationship of job to marriage and child rearing)

DECISION MAKING
(including the influences in early life which affected her decision to become a scientist)

WOMAN SCIENTIST BUDDY SYSTEM

Arrange with women scientists, mathematicians, and engineers in the community to pair with girls in the science and mathematics classes to provide information about their work and to relate course work with scientific work. The buddy system will provide encouragement and motivation for girls to go on in science. Activities of various kinds may be planned, including visits to the school, to the place of the scientist's employment, to each other's homes, or maybe just chats over soft drinks.

CAREER EXPLORATION ACTIVITY LIST

Locate activities in the community that relate to scientific occupations. The type of activities available may be meetings of organizations such as the Amateur Astronomy Society, an amateur radio club, the Society of Women Engineers, the Association for Women in Mathematics, and American Women in Science. The CAREER INFORMATION in this CAREER GUIDE lists examples of the scientific organizations available in larger communities.

Programs by businesses, laboratories, colleges, and universities, which do scientific work, should not be overlooked. Indicate the scientific fields represented by each activity and the resource people available, particularly women scientists.

Make this list available to teachers and students in your school.

CAREER EXPLORATION FOLLOW-UP

As a follow-up to a career activity list, do community career exploration visitations. Take some female students with you. When you visit the location of the scientific activity, plan to:

1. talk to resource people
2. meet with college representatives
3. visit businesses or industries to observe and talk to people about their jobs
4. visit nearby colleges, universities, and vocational schools to talk to personnel

During these visits, seek out women scientists to be included in the various career activities you plan for your school. Encourage these community resource people to become involved in your school's career education activities.

SCIENCE FIELD TRIPS AND WORK DEMONSTRATIONS

As another follow-up to career exploration activities, arrange for field trips to locations where scientific work is done. Possibilities include industry, laboratories, nearby colleges, vocational schools, career education centers, hospitals (human and animal), medical centers, and dental clinics. Select locations where women will be seen doing scientific work. If at all possible, have the students speak on an informal basis with women workers.

It is sometimes possible to arrange for personnel to come to the school and present a scientific demonstration explaining some phenomenon of interest to the students.

PARENT INVOLVEMENT

Involve parents in their daughters' career planning. Arrange conferences with both large groups of parents and individuals. On an individual basis, review each student's interests, aptitudes, and academic record. The STUDENT CHECKLIST in the CAREER GUIDE is a good starting place for discussion.

In the group sessions, provide parents with career information. The CAREER INFORMATION in this CAREER GUIDE may be helpful. It may be beneficial to include the young woman in the parent conference. A discussion on financial aid possibilities will be of interest to the parents and to the future scientist as well.

TO THE CAREER EDUCATOR:

USING THE STUDENT CHECKLIST

There are no right or wrong answers. The purpose of the checklist is mainly to help students think through their own interests, abilities, and acquired skills.

The checklist can be used with junior high school students as a way to create awareness and to facilitate planning of their high school program.

It is a valuable tool at the senior high level. It provides a way to affirm or disaffirm the student's potential for and interest in science or engineering.

SECTION A examines the student's interests. If the majority of the responses are *yes*, he or she may be interested in science and should be encouraged. In particular, *yes* responses to numbers 1, 2, 10, 11, and 12 may indicate an interest in applied science and a bent toward engineering and technology.

SECTION B is directed toward the student's abilities. Here again, a majority of *yes* responses would indicate an aptitude for science and mathematics. *Yes* responses on numbers 5 and 6 also might mean a tendency toward applied sciences.

SECTIONS C and D give the student a chance to consider his or her acquired skills and to determine where additional skill building is necessary. If the majority of the responses are *yes*, the student is obviously well prepared to tackle a future in the sciences.

If both interest and ability are evident and the student possesses reasonable skills, a discussion concerning science career possibilities is indicated.

STUDENT CHECKLIST

A. DO YOU LIKE: YES NO SOMETIMES

1. to fix things?
2. to make things?
3. to be independent?
4. to create things?
5. to explore?
6. to learn?
7. to be challenged by new situations and ideas?
8. to do puzzles?
9. to solve problems?
10. to work out mathematical problems?
11. to tinker with or build mechanical things?
12. to play with numbers?
13. to work with details?
14. to attend and to do the work in your mathematics courses?
15. to attend and to do the work in your science courses?
16. to play or listen to music?

B. ARE YOU:

1. inquisitive?
2. persistent?
3. precise?
4. imaginative?
5. mechanical?
6. adept with your hands?
7. challenged by mathematical problems?
8. able to concentrate for long periods of time?

C. CAN YOU:

1. apply knowledge to unfamiliar situations?
2. stick with tasks or problems which may be time-consuming and/or difficult?

	YES	NO	SOMETIMES
3. study effectively?			
4. organize your time and work?			
5. work independently?			
6. communicate well with others?			
7. express your ideas clearly?			
8. write well?			
D. DO YOU HAVE:			
1. a disciplined approach to getting a job done?			
2. physical stamina?			
3. good ACT or SAT scores?			
4. a strong high school program in:			
a. English			
b. Foreign languages (two years)			
c. Social Studies			
d. Science, including biology, physics, chemistry			
e. Mathematics, including algebra (two years), geometry, trigonometry, calculus			

CAREER INFORMATION FOR AND ABOUT WOMEN

If a charge for an item is required or known, it is indicated.

WOMEN IN PHYSICS

American Physical Society
Committee on the Status of Women
335 East 45th Street
New York, N.Y. 10017
(ISBN: 0-88318-23-7 single copy free; multiple copies 50¢)

QUOTES FROM DU PONT ENGINEERS

College Relations Manager
Du Pont Company
Wilmington, Del. 19898

Brochure about women engineers working for DuPont with photos and statements by the women.

WOMEN IN ENGINEERING AT KODAK

Corporate Information Department
Eastman Kodak Company
Rochester, N.Y. 14650

YOUR TOMORROW — A GUIDE TO CAREERS IN THE CHEMICAL INDUSTRY

Manufacturing Chemists Association
1825 Connecticut Avenue, NW
Washington, D.C. 20009

Shows pictures and gives information about several women and their jobs.

MEDICINE: A WOMAN'S CAREER

American Medical Women's Association
1740 Broadway
New York, N.Y. 10019 (price: $1.00)

CAREERS FOR WOMEN IN THE SEVENTIES

Women's Bureau, Employment Standards Administration
U.S. Department of Labor
Washington, D.C. 20402 (GPO 50¢)

Describes professional and technical careers, including careers in science. A valuable source for making comparisons of job opportunities and salaries.

WOMEN IN ENGINEERING (Directory of College/University Programs)

American Society of Engineering Education
One Dupont Circle, Suite 400
Washington, D.C. 20036

I'M MADLY IN LOVE WITH ELECTRICITY

Nancy Kreinberg
Lawrence Hall of Science
University of California
Berkeley, California 94720
ATTN: CAREERS (price $2.00)

Comments about their work by women in science and engineering.

WOMEN IN ENGINEERING

Purdue University
West Lafayette, Indiana 47907

Career brochure inviting women to consider an engineering career.

WOMEN IN SCIENCE AND TECHNOLOGY: CAREERS FOR TODAY AND TOMORROW

ACT Publications
P.O. Box 168
Iowa City, Iowa 52240 (price $1.50)

Booklet with numerous photos and quotations of women scientists and engineers. Includes an eight-step plan for a successful career.

WOMEN AND MINORITIES IN SCIENCE AND ENGINEERING

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
(Stock # 038-000-00307-1 price 75¢)

A statistical report on women and minority scientists, including population, salaries, and employment. NSF publication.

WOMAN ENGINEER

Sara Jane Newstadtl
Engineer's Council for Professional Development
345 East 47th Street
New York, N.Y. 10017

Looks at engineering as a profession for women and how women fit in. Explores various types of jobs held by women who are engineers. Direct quotations are included.

THINKING ABOUT ENGINEERING

(Purdue Women Engineers Speak Out)

Co-op Program Coordinator
Office of the Dean
School of Engineering
Purdue University
West Lafayette, Indiana 47907

Personal accounts of women engineering students offering insight and comments on the engineering field for women.

MINORITIES IN ENGINEERING

The Minority Engineering Education Effort, Inc. (ME^3)
345 East 47th Street
New York, N.Y. 10017

Discusses abilities needed by an engineer, requirements for college admission, job information, and salaries. Although not specifically about women, women are pictured in classroom situations.

MAKING IT IN ENGINEERING

Engineer's Council for Professional Development
345 East 47th Street
New York, N.Y. 10017

Biographical information on minority men and women engineers. Includes photographs and information on their work.

SCIENCE CAREER EXPLORATION FOR WOMEN

Walter Smith and Kala Stroup
National Science Teachers Association
1201 16th Street, NW
Washington, D.C. 20036 (price: $2.50)

A booklet which looks at career exploration for women and provides six career exploration activities.

WHAT CAN SHE BE? A GEOLOGIST
WHAT CAN SHE BE? A VETERINARIAN

Esther and Gloria Goldreich
Lothrop, Lee, & Shepard Co.
New York, N.Y.

Two books which provide vocational guidance on the elementary level. In the first book, Ina Brown is a geologist who climbs mountains and uses a microscope to find out how the earth has changed over a million years. She is shown with her sons.

The second book shows Dr. Penny examining animals, taking x-rays, and performing surgery. Photographs are included in both books.

WOMEN IN MEDICINE

Carol Lopate
Johns Hopkins Press
Baltimore, Md.

Book about the experiences of women in medical training. Includes a history of women's entrance into formal medical profession. Explores factors which motivate, or dc not motivate, women to enter medicine, such as counseling practices. Also has section on financing a medical education. Although it states that it is intended for young women thinking about medical careers, their advisors, and teachers, it is mainly directed to the latter two groups.

WHY WOULD A GIRL GO INTO MEDICINE?

Margaret A. Campbell
Feminist Press
Old Westbury, N.Y.

A survey of sex discrimination in the U.S. medical schools.

DOCTORS WANTED: NO WOMEN NEED APPLY

Mary Roth Walsh
Yale University Press
New Haven, Conn.

Subtitled "Sexual Barriers in the Medical Profession, 1835-1975". The author asserts that the medical establishment deliberately limited women physicians.

PARENTS PROTECT YOUR CHILDREN'S FUTURE

The Third College, Q-015
University of California
San Diego, LaJolla, California 92093

An attractive brochure with a message that is very clear in its subtitle: "Have them take algebra and geometry in high school". It is not directed specifically at parents of daughters, but they, in particular, need its message. Attitudinal problems in mathematics are discussed along with the necessity for non-college and college bound students to take courses in mathematics.

REPORTS — CONFERENCE PROCEEDINGS

CAREER GUIDANCE FOR WOMEN ENTERING ENGINEERING

Nancy Fitzroy, editor
Society of Women Engineers
Suite 305, 345 East 47th Street
New York, N.Y. 10017

Proceedings of an Engineering Foundation Conference, New England College, Henniker, New Hampshire, August 19-24, 1973. An excellent resource for role models.

THE DOUBLE BIND: THE PRICE OF BEING A MINORITY WOMAN IN SCIENCE

American Association for the Advancement of Science
1515 Massachusetts Avenue, NW
Washington, D.C. 20005
(AAAS Publication 76-R-3)

Report on 1975 conference of minority women scientists at Arlie House, Warrenton, Virginia prepared by Shirley Malcom, Paula Hall, and Janet Brown. Includes statistical data, list of participants, and a bibliography.

SPACE FOR WOMEN: PERSPECTIVES ON CAREERS IN SPACE

The Women's Center
Center for Astrophysics
60 Garden Street
Cambridge, Massachusetts 02138

A report from an October 1975 symposium on careers for women in astronomy, astrophysics, and earth and planetary sciences which was sponsored by the Center for Astrophysics, Harvard University, Radcliffe College, and the Smithsonian Institution. Contains career information and biographical material on symposium participants.

WOMEN IN ENGINEERING: BRIDGING THE GAP BETWEEN SOCIETY AND TECHNOLOGY

George Bugliarello, Vivian Cardswell, Olive Solembier, and Winifred White
College of Engineering
University of Illinois at Chicago Circle
Box 4348
Chicago, Illinois 60680

Proceedings of an Engineering Foundation Conference, dated July 12-16, 1971, at New England College, Henniker, New Hampshire. Includes text of speeches as well as recommendations and resolutions resulting from the conference workshops.

WOMEN IN ENGINEERING . . . BEYOND RECRUITMENT

Mary Diederich Ott and Nancy Reese, editors
Cornell University
Ithaca, New York

Proceedings of a conference on June 22 to 25, 1975. The conference included invited papers, responses by panelists, workshops, and question/answer sessions. The report includes the invited papers.

WOMEN IN ENGINEERING

College of Engineering
University of Washington
Seattle, Washington

Proceedings of a November 7, 1974 conference. Contains the text of conference speeches, summary of workshops, and conference resolutions.

WOMEN IN SCIENCE AND TECHNOLOGY

Edith Ruina, editor
MIT Press
Cambridge, Massachusetts

Report on workshop on women in science and technology which was held May 21-23, 1973 at MIT.

WOMEN IN THE SCIENTIFIC PROFESSIONS

Jacquelyn Mattfeld and Carol Van Aken, editors
MIT Press
Cambridge, Massachusetts

This book includes the text of speeches at the conference, which was held in 1965. Addresses were given by such notable speakers as Alice Rossi, Bruno Bettleheim, James Killian, Mary Bunting, Erik Erikson, Jessie Bernard, and Lillian Gilbreth. Of special interest is Rossi's paper: "Barriers to the Career Choice of Engineering, Medicine, or Science among American Women." It is an important source for understanding the influences which prevent women from pursuing scientific careers.

PROFESSIONAL ORGANIZATIONS FOR WOMEN

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Office of Opportunities in Science
Janet Brown, Director
1776 Massachusetts Avenue, NW
Washington, D.C. (202) 467-4496

Women's Caucus
Beatrice Bain, Chair
Office of the Provost
University of California-Berkeley
Berkeley, CA 94720 (415) 642-1638

AMERICAN ASTRONOMICAL SOCIETY

Dr. Henry L. Shipman
Physics Department, University of Delaware
Sharp Laboratories
Newark, Del. 19711

AMERICAN CHEMICAL SOCIETY

Women Chemists Committee
Nina Roscher, Chair
American University
Department of Chemistry
Washington, D.C. 20016 (202) 686-2445

Mary Symuleski, Staff Liaison
115 16th Street, NW
Washington, D.C. 20036 (202) 833-4700

AMERICAN GEOLOGICAL INSTITUTE

Women Geoscientists Committee
Virginia Sand, Chair
Tuscarawas Campus, Kent State University
New Philadelphia, Ohio 44663

AMERICAN INSTITUTE OF CHEMISTS

Professional Opportunities for Women Committee
7315 Wisconsin Avenue, NW
Washington, D.C. 20014

AMERICAN MEDICAL WOMEN'S ASSOCIATION, INC.

Lorranine Loesel, Executive Director
Claudine M. Gay, President
1740 Broadway
New York, NY 10019 (212) 586-8683

AMERICAN METEOROLOGICAL SOCIETY

Women's Committee
45 Beacon Street
Boston, Mass. 02108 (617) 227-2425

AMERICAN PHYSICAL SOCIETY

Committee on the Status of Women in Physics
Caroline Herzenberg, Chair
Argonne National Laboratory, Building 316
Argonne, Illinois 60439 (312) 972-6123

AMERICAN PHYSIOLOGICAL SOCIETY

Task Force on Women in Physiology
Elizabeth Tidball, Chair
Department of Physiology
George Washington University
2300 1st Street, NW
Washington, D.C. 20037 (202) 331-6559

Mary Dittbrenner, Staff Liaison
9650 Rockville Pike
Bethesda, Maryland 20014 (301) 530-7164

AMERICAN SOCIETY OF BIOLOGICAL CHEMISTS

Committee on Equal Opportunities for Women
Loretta Leive and Ann E. Kaplan, Co-chairs
National Institute of Health
Bldg. 4, Room 116 or Bldg. 6, Room 110
Bethesda, Maryland 20014 (301) 496-2140 or (301) 496-5415

AMERICAN SOCIETY FOR CELL BIOLOGY

Women in Cell Biology
Mary E. Clutter
Osborn Memorial Laboratories
Department of Biology
Yale University
New Haven, Conn. 06520 (203) 432-4298

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Women's Action Group
Donna Frohreich, Chair
University of the Pacific
Stockton, CA 95211

AMERICAN SOCIETY FOR MICROBIOLOGY

Committee on the Status of Women Microbiologists
Jessie Price, Chair
National Fish and Wildlife Health Laboratory
1655 Linden Drive
Madison, Wisconsin 53706

ASSOCIATION OF AMERICAN WOMEN DENTISTS

435 North Michigan Avenue, Suite 1717
Chicago, Illinois 60611 (312) 644-0828

ASSOCIATION OF WOMEN GEOSCIENTISTS

P.O. Box 1005
Menlo Park, CA

ASSOCIATION FOR WOMEN IN MATHEMATICS

Lenore Blum, President
Department of Mathematics and Computer Science
Mills College
Oakland, CA 94613 (415) 632-2700 Ext. 347

ASSOCIATION FOR WOMEN IN SCIENCE

1346 Connecticut Avenue, NW, Suite 1122
Washington, D.C. 20036 (202) 833-1998

BIOPHYSICAL SOCIETY

Committee on Professional Opportunities for Women
Women's Caucus
Paula Beall, Chair
Department of Pediatrics
Baylor College of Medicine
1200 Moursund
Houston, Texas 77030 (713) 521-3200

NATIONAL SCIENCE FOUNDATION

Women in Science Program
Joan Callahan, Director
1800 G Street, NW
Washington, D.C. 20550 (202) 282-7150

SOCIETY OF WOMEN ENGINEERING TECHNICIANS

Janet O'Brien
Mechanical Drafting and Design Technology
Guilford Technical Institute
Jamestown, North Carolina 27282

SOCIETY OF WOMEN ENGINEERS

United Engineering Center, Room 305
345 East 47th Street
New York, N.Y. 10017 (212) 644-7855

WOMEN'S VETERINARY MEDICAL ASSOCIATION

Dorothy Gustafson, Executive Secretary
2175 West Highway No. 36
Rosevill, Maine 55113

GENERAL SOURCES

AMERICAN ASTRONOMICAL SOCIETY
Dr. Henry L. Shipman
Physics Department, University of Delaware
Sharp Laboratories
Newark, Del. 19711

AMERICAN CHEMICAL SOCIETY
1155 16th Street, NW
Washington, D.C. 20036

AMERICAN GEOLOGICAL INSTITUTE
5205 Leesburg Pike
Falls Church, Virginia 22041

AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS
1290 Avenue of the Americas
New York, N.Y. 10019

AMERICAN INSTITUTE OF PHYSICS
335 East 45th Street
New York, N.Y. 10017

AMERICAN MATHEMATICAL SOCIETY
P.O. Box 6248
Providence, Rhode Island 02940

AMERICAN METEOROLOGICAL SOCIETY
45 Beacon Street
Boston, Massachusetts 02108

AMERICAN SOCIETY OF AGRONOMY
CROP SCIENCE SOCIETY OF AMERICA
SOIL SCIENCE SOCIETY OF AMERICA
677 South Segoe Road
Madison, Wisconsin 53711

AMERICAN SOCIETY OF CIVIL ENGINEERS
345 East 47th Street
New York, N.Y. 10017

BOTANNICAL SOCIETY OF AMERICA
New York Botannical Gardens
Bronx, N.Y. 10458

COMMITTEE OF PRESIDENTS OF STATISTICAL SOCIETIES
c/o AMERICAN STATISTICAL ASSOCIATION
806 15th Street, NW
Washington, D.C. 20005

ELECTRONIC INDUSTRIES ASSOCIATION
2001 Eye Street
Washington, D.C. 20006

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT
345 East 47th Street
New York, N.Y. 10017

ENTOMOLOGICAL SOCIETY OF AMERICA
4603 Calvert Road
P.O. Box AJ
College Park, Maryland 20740

INSTITUTE OF FOOD TECHNOLOGISTS
Suite 2120 North LaSalle Street
Chicago, Illinois 60601

INSURANCE INFORMATION INSTITUTE
110 William Street
New York, N.Y. 10038

INTERNATIONAL OCEANOGRAPHIC FOUNDATION
3979 Rickenbacker Causeway
Virginia Key
Miami, Florida 33149
(Brochure: "Training and Careers in Marine Science," 50¢)

MANUFACTURING CHEMISTS ASSOCIATION
1825 Connecticut Avenue, NW
Washington, D.C. 20036
(For visiting lectureship program "Women and Mathematics", contact Eileen L. Poiani, St. Peter's College, Jersey City, N.J. 07306)

THE METALLURGICAL SOCIETY OF AIME
345 East 47th Street
New York, N.Y. 10017

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS
1609 Association Drive
Reston, Virginia 27091

NATIONAL SCIENCE TEACHERS ASSOCIATION
1201 16th Street, NW
Washington, D.C. 20036

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS
2029 K Street, NW
Washington, D.C. 20006

SCIENTIFIC MANPOWER COMMISSION
1776 Massachusetts Avenue, NW
Washington, D.C. 20036
Booklet: SCIENCE AND ENGINEERING CAREERS; a Bibliography (7th edition)
Single copy: $2.00; 25 or more: $1.00 each

UNITED STATES CIVIL SERVICE COMMISSION
Washington, D.C.
GUIDE TO FEDERAL CAREER LITERATURE (GPO price: $1.05)

UNITED STATES DEPARTMENT OF LABOR
Bureau of Labor Statistics
Washington, D.C.

OCCUPATIONAL OUTLOOK HANDBOOK (GPO Bulletin 1955; price $8.00)

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SELECTED SOURCES OF FINANCIAL AID

EDUCATIONAL FINANCIAL AIDS

AAUW Sales Office
2401 Virginia Avenue, NW
Washington, D.C. 20037 (price: $1.00)

DIRECTORY OF SPECIAL PROGRAMS FOR MINORITY GROUP MEMBERS

Willis Johnson, Editor
Garret Park Press
Garret Park, Maryland 20766

Contains special section on women.

SCHOLARSHIPS ADMINISTERED BY SOCIETY OF WOMEN ENGINEERS

BERTHA LAMME-WESTINGHOUSE SCHOLARSHIPS

Supported by a grant from Westinghouse Education Foundation in memory of the first woman engineer employed by Westinghouse. Given to entering freshman women to attract them to the field of engineering.

TRW SCHOLARSHIPS

Supported by TRW Foundation for freshman women majoring in engineering.

GENERAL ELECTRIC FOUNDATION SCHOLARSHIPS

For outstanding women students who will be incoming freshmen in a school accredited by the Engineering Council for Professional Development. Continued for four years if the students maintain good scholastic averages.

AWARDS GIVEN BY SOCIETY OF WOMEN ENGINEERS

SOCIETY'S CERTIFICATE OF MERIT

Administered by Sections and Members-at-large in the localities to honor high school girls who have demonstrated three years of excellence in mathematics and science.

CERTIFICATE OF ACHIEVEMENT

Administered locally to recognize girls who have demonstrated special achievement in technical and scientific studies or projects.

THE ROLE MODELS

Dear Educator,

Without role models, girls are unlikely to aspire to scientific and technical occupations. Women scientists have been few in number so that young girls rarely have the opportunity to meet and to observe one. It is even possible to be totally unaware that women can be scientists and engineers.

The ROLE MODELS section of this packet provides an opportunity for girls and women to acquire a sense of female accomplishment in the sciences. Indeed, you may find some of these accomplishments surprising, particularly those which we take for granted in our everyday lives.

Because there are more women scientists than can possibly fit in the next few pages, organization and selection were major problems, especially as I wished to provide more than a date, job title, and list of achievements. Young girls want to know about the personal lives of women and, in particular, how their work combined with their families and marriages. To meet this need and to illustrate the vast abilities and achievements of women scientists, the ROLE MODELS section is organized into three major parts:

1. *Information about the outstanding and unusual accomplishments of women in science.*
2. *A list of women whose achievements are well known and whose lives are reasonably well documented in other sources. The lives of these women can be further studied and expanded by use of materials in the RESOURCES section.*
3. *Short biographies of less well-known women who are still active in their fields.*

I hope that you will use some of the activities in the CURRICULUM section, in combination with the ROLE MODELS and RESOURCES sections, to do more in-depth studies of the lives of women scientists.

Sharon L. Menard

THE EXCEPTIONAL WOMEN

"Ability has nothing to do with sex."
Florence Sabin, medical researcher

The women listed in the following pages are unique, outstanding individuals. Their achievements required courage and persistence. Florence Sabin, who is outstanding even among these role models, encouraged women to pursue scientific careers. She stated that sex is not the determining factor for ability in science. For research, Sabin insisted, one needs accuracy, deftness, and patience along with the necessary qualifications of intelligence, interest, the will to work, persistence, common sense, and imagination.

Many girls currently in our educational systems have intelligence, persistence, common sense, and imagination. These girls can bring their qualifications to fields of science. They are more likely to do so if they know that these fields are possible for women and that women have achieved notable success in the sciences. This is a collection of exceptional people, not exceptional women. Even if they had been male, their achievements would be notable.

The RESOURCES section of this packet provided material for this section. The achievements are only brief glances at the lives of women discussed here. They represent the culmination of a lifetime of work and preparation. The personalities, as well as the personal lives, of the women are as interesting and unique as their contributions to the world of science. The information here is only a starting point. You are encouraged to continue to read further about these scientists.

WOMEN SCIENTISTS WHO WON NOBEL PRIZES

Nobel Prizes have been awarded for science annually since 1901. Awards are made in the following fields: chemistry, physics, and physiology or medicine. In the scientific world, the Prize represents the pinnacle of scientific achievement.

YEAR	NAME	FIELD	ACHIEVEMENT
1903	MARIE CURIE France (shared with her husband, Pierre, and A.H. Becquerel)	Physics	Investigations of radiation phenomena discovered by A.H. Becquerel
1911	MARIE CURIE France	Chemistry	Discovery of radium and polonium; isolation of radium
1935	IRENE JOLIET-CURIE France (shared with her husband, Frédéric)	Chemistry	Synthesis of new radioactive elements
1947	GERTY CORI United States	Physiology/ Medicine	Discovery of how glycogen is catalytically converted
1963	MARIA GOEPPERT-MAYER United States (shared with J. Hans Jensen and Eugene Paul Wigner)	Physics	Development of shell model theory of structure of atomic nuclei
1964	DOROTHY M.C. HODGKIN Britain	Chemistry	Determining the structure of biochemical compounds essential in combating pernicious anemia
1977	ROSALYN S. YALOW United States	Physiology/ Medicine	Development of radioimmunoassay technique to detect and measure minute levels of substances such as hormones in the body

WOMEN WHO CAME FIRST

"A sphere is not made up of one, but an infinite number of circles; women have diverse gifts and to say that women's sphere is the family circle is a mathematical absurdity."

Maria Mitchell, astronomer

(1750-1848) CAROLINE HERSCHEL, English astronomer

First woman to detect a comet
First woman to obtain a paid government position in England (as assistant court astronomer to her brother William)
First woman (along with Mary Somerville) to be elected an honorary member of the Royal Astronomical Society of England

1815-1852 ADA BYRON LOVELACE, English mathematician

First person to program a computing machine

1818-1889 MARIA MITCHELL, American astronomer

First woman astronomer in the United States
First professor of astronomy at Vassar College
First director of Vassar Observatory
First woman elected to American Academy of Arts and Sciences
First woman member of the American Association for the Advancement of Science

(1821-1910) ELIZABETH BLACKWELL, American physician

First woman in the United States to obtain an M.D.

(1831-1903) EMILY HOWARD JENNINGS STOWE, Canadian physician

First woman to practice medicine in Canada

(1833-1910) LUCY HOBBS TAYLOR, American dental surgeon

First woman in the United States to attend and graduate from dental school

(1836-1917) ELIZABETH GARRETT ANDERSON, English physician

First woman certified as a medical doctor in England

(1840-1912) SOPHIA JEX-BLAKE, English physician

First woman (along with four other women) to attend medical school at the University of Edinburgh, Scotland

(1842 [illegible]06) MARY PUTNAM JACOBI, American physician

First woman to be admitted to Ecole de Médicine, Paris, France. Received doctor's degree in 1871.

(1842-1911) ELLEN SWALLOW RICHARDS, American chemist

First woman to graduate from Massachusetts Institute of Technology (MIT)
First woman faculty member at MIT
First woman science consultant to industry

ROLE MODELS

(1845-1913)	ISABEL BARROWS, American ophthalmologist First woman eye doctor in the United States
(1847-1927)	SARAH WHITING, American physicist First woman to study physics at MIT
(1850-1891)	SONYA KOVALEVSKI, Russian mathematician First woman corresponding member of the Russian Academy of Sciences
(1854-1930)	ANNA BOTSFORD COMSTOCK, American naturalist First woman professor at Cornell University One of four original women members initiated in Sigma Xi, the national honor society of the sciences
(1860-1944)	MARGARET ELIZA MALTBY, American physicist First American woman to receive the PhD degree at Gottingen University in Germany Also listed in the first edition of American Men of Science
(1862-1945)	FLORENCE BASCOM, American geologist First woman to receive the PhD degree from Johns Hopkins University
(1863-1941)	ANNIE JUMP CANNON, American astronomer First woman to receive a gold medal from the U.S. Academy of Sciences
(1867-1934)	MARIE CURIE, Polish-French physicist and chemist First woman to receive a Nobel Prize and the only woman to receive two Nobel Prizes First woman professor at the Sorbonne in Paris, France
(1868-1944)	GRACE CHISHOLM YOUNG, English mathematician First woman to receive an official doctorate in any subject at a German university
(1869-1970)	ALICE HAMILTON, American pathologist First woman to receive the Lasker Award of the American Public Health Association
(1871-1953)	FLORENCE SABIN, American medical researcher First woman on the faculty at Johns Hopkins Medical School and the only woman to become a full professor
(1873-1945)	SARA JOSEPHINE BAKER, American pediatrician Head of the first U.S. Child Hygiene Bureau
(1882-)	CONNIE MEYERS GUION, American physician First woman full professor at Cornell Medical College in Ithaca, New York First woman to have a hospital named for her

(1884-1959)	SARA JORDAN, American gastroenterologist First person to receive the Julius Friedenwall award for outstanding achievement in gastroenterology
(1898-)	HELEN TAUSSIG, American physician First woman president of the American Heart Association First woman to receive the Passano Foundation award for medical research
(1898-)	KATHERINE BURR BLODGETT, American physicist First woman to receive a PhD degree in physics from England's Cambridge University
(1903-)	DAME KATHLEEN LONSDALE, English crystallographer First woman (along with Marjory Stephenson) to be elected as a Fellow of the Royal Society of England (March 1944)
(1909-)	VIRGINIA APGAR, American physician First woman full professor at Columbia Medical School
(1910-)	MARY BUNTING, American microbiologist First woman member of the U.S. Atomic Energy Commission
(1913-)	ANNA J. HARRISON, American chemist First woman to be elected president of the American Chemical Society (in 1977)
(1914-)	DIXIE LEE RAY, American marine biologist First woman to chair the U.S. Atomic Energy Commission First woman governor of the State of Washington (1976)
(1937-)	VALENTINA TERESHKOVA, Russian cosmonaut First woman cosmonaut in the world

BLACK WOMEN WHO CAME FIRST

NAME	FIELD, UNIVERSITY, DATE
REBECCA LEE	Medicine, New England Female Medical College, 1864
IDA GRAY	Dentistry, University of Michigan, 1890
RUTH MOORE	PhD, Bacteriology, Ohio State University, 1933
JESSIE JARUE MARK	PhD, Botany, Iowa State University, 1935
FLEMMIE P. KITTRELL	PhD, Nutrition, Cornell University, 1936
ROGER ARLINER YOUNG	PhD, Zoology, University of Pennsylvania, 1940
RUTH LLOYD	PhD, Anatomy, Case Western Reserve University, 1941
MARGUERITE THOMAS	PhD, Geology, Catholic University, 1942
MARIE DALY	PhD, Chemistry, Columbia University, 1947
EVELYN BOYD COLLINS	PhD, Mathematics, Yale University, 1949
MARJORIE BROWNE	PhD, Mathematics, Michigan University, 1949

SOURCES:

Jay, James M. NEGROES IN SCIENCE
(Natural Science Doctorates 1876-1969)
Balamp Publishing, 1971
Box 7390, Detroit, Michigan 48202

Carwell, Hattie BLACKS IN SCIENCE
Exposition Press, 1977
Hicksville, N.Y.

INVENTIONS BY WOMEN

The U.S. Patent Office reports numerous inventions by women, including a horse's feed bag, a shade for over a horse's head, and white lines on roads. On May 5, 1809, Mary Kies was the first woman to receive a patent; it was for a process of straw-weaving with silk or thread.

Earlier, Sibella Masters, who died in 1720, developed a new method of cleaning and airing corn and became the first American inventor to receive a British patent, but it was recorded in her husband's name. Eliza Lucas Pinckney (1723-1793) was an agronomist who perfected a method for cultivating and extracting indigo, a very important product in South Carolina's economy.

By 1910, one hundred years after Mary Kies' patent, over 10,000 patents had been issued to women. Women did not confine their inventive genius to domestic articles, although items such as an ice cream freezer, a weighing scale, and a fan attachment for a rocking chair do appear in patent records. Instead, female inventiveness went further afield. For example, the most remarkable invention by a woman during 1841-1851 was a submarine telescope and lamp, patented by Sarah Mather in 1845. During 1851-1861, patents granted to women included mounting of fluid lenses, a fountain pen, and an improvement in reaping and mowing machines. In the next decade, female patents appear for locomotive wheels, devices for reducing straw and other fibrous substances for the manufacture of paper pulp, low-water indicators, fire alarms, railroad car heaters, burglar alarms, and a device for desulphurizing ores.

In 1871, Miss Margaret Knight of Boston was awarded a patent for a paper-bag machine, but she did not simply file for a patent. She successfully used it in a manufacturing business. She and some other women inventors derived considerable incomes from their patents. For instance, there was a woman in San Francisco in the 1800's who received $14,000 for her invention of a baby carriage.

The first black woman inventor of record was Sarah E. Good, whose patent dated July 14, 1885 for a folding cabinet bed. The next black woman of record is Sarah Boone, who patented an ironing board on April 26, 1892. Other inventions by women include:

*** a pneumatic tire

*** heating and ventilating apparatus for buildings

*** railroad cars

*** air-cooling fans

*** a digging machine

*** a snow plow

*** a snow shovel and scraper

*** stage scenery

*** several types of paving blocks

*** fire escapes

SOURCES: Ireland, Norma Olin. INDEX TO WOMEN OF THE WORLD
F.W. Faxon Co., 1970
Westwood, Mass.

Mozans, H.J. WOMEN IN SCIENCE
MIT Press, 1974 (reprint of 1913 edition)
Cambridge, Mass.

SELECTED NOTABLE WOMEN SCIENTISTS

*"Never so few (women) contributed so much under such trying circumstances!
Why should we not encourage more girls to go to science?"*

Chien-Shiung Wu, nuclear physicist

The women included in these pages are a small sample of women of notable scientific achievement. Their work, with some exceptions, mainly occurred within the 20th century. Several are still living today. The intent is to provide role models who are from the recent past and whose biographies are available in some written form, such as is listed in the RESOURCES section.

For girls to relate to the women scientists discussed here, further exploration into their lives is important. Although girls should know about the work done by these women, they also need to know how they combined marriage and children with their work as scientists. Therefore, it is essential to build on this information with other curriculum and career activities, including research on the lives of these scientists.

PHYSICAL SCIENCES

(1750-1848) CAROLINE HERSCHEL, German-English astronomer

Discovered seven comets and many nebulae. Received medal from Royal Society of England and gold medal from King of Prussia for her work.

(1818-1889) MARIA MITCHELL, American astronomer

Discovered comet. Worked as observer for first American Ephermeris and Nautical Almanac.
Awarded prize for comet discovery by King of Denmark.

(1842-1911) ELLEN SWALLOW RICHARDS, American chemist, mineralogist, sanitary engineer, and pioneer home economist

Studied water, sanitation and nutrition.

(1848-1915) MARGARET LINDSAY (Lady Huggins), English astronomer

Mapped sun spots. Introduced the use of spectroscopy and photography in astronomy.

(1858-1944) MARY ADELA BLAGGS, astronomer

Compiled list of lunar formations. Performed comprehensive work for International Astronomy Union's Commission on Lunar Nomenclature.

(1863-1941) ANNIE JUMP CANNON, American astronomer

Identified and classified more stars than anyone else in the world. Discovered five infrequent novae (stars that blaze up to great brightness).

(1867-1934) MARIE SKLODOWSKA CURIE, Polish-French physicist; chemist

Discovered polonium and radium. Explained the phenomenon of radioactivity. Won two Nobel Prizes.

(1868-1921) HENRIETTA LEAVITT, American research astronomer

Studied variable stars at Harvard Observatory.
Discovered the period-luminosity relationship of variable stars.

(1878-1968) LISE MEITNER, Austrian theoretical physicist

Explained atomic fission (splitting of the atom).

(1897-1956) IRENE JOLIET-CURIE, French physicist

Researched radioactivity, which lead to the synthesis of new radioactive elements. Won Nobel Prize.

(1898-) KATHERINE BURR BLODGETT, American research physicist; chemist

Discovered how to make nonreflecting glass, which led to the improvement of camera and telescope lenses.

(1905-) HELEN SAWYER HOGG, Canadian astronomer

Studied globular star clusters. Catalogued 1116 variable stars. Awarded Annie Jump Cannon Prize for outstanding contribution to astronomy.

ROLE MODELS

(1906-1972)	MARIA GOEPPERT-MAYER, German-American physicist Discovered structure of atom's nucleus. Won Nobel Prize.
(1912-)	CHIEN-SHIUNG WU, Chinese-American nuclear physicist Explained concept of the physicial structure of the universe.
(1921-1958)	ROSALIND FRANKLIN, physicial chemist Researched the structure of DNA, fundamental molecules of life, using x-ray diffraction techniques. Her work provided the experimental results which were the basis for discovering the structure of DNA.

LIFE SCIENCES

(1869-1970) **ALICE HAMILTON**, American pathologist, physician

Became America's foremost authority on illnesses caused by toxic chemicals used in industry.

(1871-1953) **FLORENCE RENA SABIN**, American medical researcher, anatomist

Studied blood cells, which led to a better understanding of diseases and the body defense system (lymphatics).

(1872-1952) **MARY ENGLE PENNINGTON**, American bacteriological chemist; engineer

Became authority on the refrigeration of perishable foods.

(1879-1954) **MAUDE SLYE**, American pathologist

Performed cancer research which established relationship of malignancy resistance and heredity.

(1884-1959) **SARA MURRAY JORDAN**, American physician, gastroenterologist

Became foremost authority on diseases of the digestive tract. Developed test to determine if ulcers are malignant.

(1886-1959) **LOUISE PEARCE**, American pathologist

Led research team at Rockefeller Institute which studied the ways of destroying a parasite which caused African sleeping sickness. Received Belgium's Order of the Crown and Royal Order of the Lion for her work.

(1888-) **LIBBIE HENRIETTA HYMAN**, American zoologist

Compiled and published five volumes on invertebrates (animals without backbones). Her work filled a gap in American scientific literature.

(1891-) **EDITH HINCKLEY QUIMBY**, American physicist; radiologist

Researched techniques of radiation therapy (x-ray treatment of cancer). Awarded medal of the American Cancer Society and the Janeway Medal, the highest honor of American Radium Society.

(1895-) **WANDA KIRKBRIDE FARR**, American biochemist

Discovered the origin of cellulose, the fundamental material in the structure of plants.

(1896-) **HAZEL K. STIEBLING**, American physicial chemist

Studied the effects of vitamin D on the body.

(1896-) **CARROLL BIRCH**, American physician; hematologist

Pioneered tropical medicine in India and Africa.

ROLE MODELS

(1896-1957)	GERTY RADNITZ CORI, Czech-American biochemist Researched abnormal growth of human body, metabolism of tumors, the body's handling of carbohydrates and sugars, and the body's use of enzymes and insulin and their effects on the blood sugar. Won the Nobel Prize.
(1897-)	FLORENCE SIEBERT, American biochemist Discovered the tuberculin which leads to tuberculosis and developed the Tine test for tuberculosis.
(1898-)	RACHEL FULLER BROWN, American biochemist Co-discovered a valuable antibiotic (with Elizabeth L. Hazen).
(1898-)	HELEN BROOKE TAUSSIG, American physician Determined causes of oxygen deficiencies in newborn, so-called blue babies (with inborn heart defects). Suggested corrective surgery. Awarded Passano Foundation award for medical research and Presidential Medal of Freedom.
(1903-)	GLADYS ANDERSON EMERSON, American biochemist Researched the effects of vitamin deficiencies on the body. Awarded Garvan Gold Medal for distinguished work in chemistry.
(1907-)	DOROTHEA RUDNICK, American embryologist Researched techniques for transplanting embryo sections, which led to an understanding of factors in growth and development.
(1907-1964)	RACHEL CARSON, American biologist Studied the effects of DDT and other poisonous chemicals on the biosphere. Published her findings in the controversial book, THE SILENT SPRING, which gave impetus to the current environmental movement.
(1908-)	RUTH PATRICK, botanist Studied the ecology of fresh water and the effects of water pollution. Won the Tyler Ecology Award, the largest cash prize given for any scientific achievement.
(1909-)	JOCELYN CRANE, American zoologist Studied behavior of small animals.
(1909-)	VIRGINIA APGAR, American physician Created Apgar Score for measuring the vital functions of a newborn baby.
(1910-)	DOROTHY CROWFOOT HODGKIN, English chemist Determined the structure of biochemical compounds which are essential in combatting pernicious anemia. Won the Nobel Prize.
(1913-)	ELIZABETH SHULL RUSSELL, American zoologist, geneticist Researched the physiological processes used by genes to produce their effects.

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(1914-) **FRANCES OLDHAM KELSEY**, Canadian-American physician

Determined the detrimental side effects of thalidomide on newborn infants and, as an employee of the U.S. Federal Drug Administration, refused to approve its public sale. Awarded Federal Civilian Service Medal by U.S. Government.

(1916-) **ELIZABETH MCGREW**, American pathologist

Developed pap smear for detecting uterine cancer.

(1926-) **MARY ELLEN AVERY**, American pediatrician

Researched pulmonary diseases in children, including surface tension in the lungs and lung metabolism.

(1928-) **NINA STARR BRAUNWALD**, American thoracic surgeon

Specialized in open heart surgery and coronary functions.

(1934-) **JANE GOODALL**, Animal behaviorist

Studied behavior of chimpanzees in Africa.

OTHER LIFE SCIENTISTS (Dates Unknown)

ALICE MCPHERSON

Developed treatment for retinal detachment of the eye.

SISTER MARY SUZANNE, French Marist missionary

Developed first vaccine for leprosy.

ALICE DEA MORANI

Developed Panoramix x-ray (cathode which is the size of a tongue depressor) used to x-ray bones of the face.

PATRICIA SULLIVAN, pediatrician

Researched tumors in children that resulted from the Hiroshima bomb.

MATHEMATICAL SCIENCES

(370-415) **HYPATIA**, Greek algebraist; teacher; inventor

Wrote commentary on the work of Diophantus (Diophantine equations whose solutions are restricted to integers). Studied conic sections (figures formed by passing a plane through a cone). Invented the astrolabe and planesphere, used in the study of stars and planets, and the aerometer or hydroscope, used for measuring water.

(1706-1749) **EMILIE DEBRETEUIL, MARQUISE DU CHÂTELET**, French mathematician

Translated Newton's PRINCIPIA into French and provided commentaries.

(1718-1799) **MARIA GAETANA AGNESI**, Italian mathematician

Brought together fragmented bits of work on the newly-developed calculus to produce a complete and integrated algebra and analysis.

(1776-1831) **SOPHIE GERMAIN**, French mathematician; mathematical physicist

Did research on number theory. Won prize for her mathematical theory of vibrations of elastic surfaces.

(1780-1872) **MARY SOMERVILLE**, Scottish mathematician

Popularized science by writing four books about the newest scientific discoveries.

(1850-1891) **SONYA KOVALEVSKI**, Russian mathematician

Won Prix Borden from the French Academy of Science for her solution to the problem of the rotation of a solid body about a fixed point.

(1868-1944) **GRACE CHISHOLM YOUNG**, English mathematician

Published first textbook on set theory in collaboration with her husband. It is considered a classic work in its field. Won Gamble Prize for her work on the foundations of differential calculus.

(1882-1935) **EMMY (AMALIE) NOETHER**, German abstract algebraist

Developed axiomatic methods,which are important in mathematical research.

(1906-) **GRACE HOPPER**, American mathematician; computer specialist

Pioneered in compiler design, the translator between humans and computers.

EARTH SCIENCES

(1913-) **FLORENCE VAN STRAATEN**, American physical chemist; meteorologist

Improved techniques for using balloons in gathering wind and weather information. Studied aspects of the problem of radioactive fallout, especially survival in case of atomic attack. Awarded U.S. Navy's Meritorious Civilian Service Award.

(1922-) **EUGENIE GLARK**, Japanese-American oceanographer; icthyologist (scientist who studies fish)

Became leading authority on shark behavior.

(unknown) **OLA WATFORD**, American geophysicist

Trained people from all over the world in geomagetism. Is currently living and possibly the only woman geophysicist and one of very few black geophysicists employed by the U.S. Government.

ENGINEERING

(1878-1972) **LILLIAN MOLLER GILBRETH**, American industrial engineer

Specialized in time and motion studies with her husband, Frank. Awarded Gantt Medal by American Society of Mechanical Engineers and American Management Association. Two of her thirteen children wrote about her in CHEAPER BY THE DOZEN and BELLES ON THEIR TOES. Pioneered in streamlined kitchen design.

WOMEN SCIENTISTS TODAY

"Being able to unravel a small aspect of the marvels of the universe..."

Sonia Gitlin, Chemist

"Girls need to think of a career-directed education. They must overcome the negative image of science and scientists."

Dr. Agnes Stroud Schmink,
Radiation Biologist

"It is especially exciting when an experiment you have designed works."

Diane Dieter, Research Technician

"In my opinion, the more women in the field the better it will be for men, women, and science."

Today's women scientists share a heritage with the great women scientists who were their predecessors. Their work is exciting. They display courage and persistence as did scientists in the past. They encourage girls to consider working in the scientific fields, but they express a word of caution: it is not all glamour. It is hard, often tedious work. They admit that it is difficult to compete in a man's world and to combine career and family, but none would do otherwise if the choice were theirs to make again.

In the next few pages, you will meet some of today's women scientists. They are a small sample of the women who have chosen one of the sciences as their profession.

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Dr. Margaret Ackerman, Chemist

Director of Metabolism and Radio Chemistry
Rhoads Scientific Company, Colorado Springs, Colorado

"I care about clean air and clean water. My work can help solve some of our environmental problems," according to Dr. Margaret Ackerman. She specializes in the chemical analysis of substances which are subject to Federal health and environmental regulations. She feels her work can make the difference in the air we breathe and the water we drink.

When she was a young girl, Dr. Ackerman thought she might be a medical doctor, but, later in college, an undergraduate chemistry professor offered an opportunity to do independent research and encouraged her to continue on in chemistry. She considers this fortunate because, as she reflects on this, she realizes that she is temperamentally unsuited for medicine and for dealing with death.

Dr. Ackerman's inclinations for science, particularly research, were very strong by the time she began high school. She attributes this to her aunt, a mathematics teacher. Dr. Ackerman admiringly describes a remarkable woman who was a strong influence on her and provided a role model. This aunt, who raised her after her mother died, encouraged her interest in science and taught her to value her freedom to be anything she wanted to be.

When Dr. Ackerman completed her bachelor's degree in chemistry, she continued into graduate school where she met her future husband, one of her students in the chemistry laboratory course which she taught. She married her student, quit her graduate studies, and took a job to help him finish his education in nuclear engineering. Her jobs included chemistry analysis work with Shell Oil Company and Lawrence Berkeley Laboratory in California.

Nine years later, when her marriage ended, she returned to New Mexico and continued her interrupted graduate studies, receiving her Ph.D. degree in 1971.

Dr. Ackerman is an active, busy person whose life is not restricted to her job. Besides her work, which she finds very satisfying, she is actively involved in politics and sports — tennis, skiing, and hiking. When she isn't on the go, she says, "I read everything."

EDUCATION: B.S. Chemistry, 1957, University of New Mexico
Ph.D. Chemistry, 1971, University of New Mexico

Diane Dieter, Biologist

Research Technician, Cancer and Transplantation Immunology
AMC Cancer Research Center and Hospital, Lakewood, Colorado

"I'm in charge of our mouse colony at AMC," says Diane Dieter. This includes genetic selection, inbreeding, and weaning. The mice are used in the research work at her laboratory. She points out that her laboratory is small and therefore "we do all the work, from dishwashing to ordering supplies to planning and executing the experiments."

When Ms. Dieter was a young girl, she thought she would be a housewife, but her mother always said she should be a veterinarian. From junior high school on, states Ms. Dieter, "science was my area." Although she liked her science classes, she had many other interests, including active participation on stage crews and in stage management. At one point in college, her avocational activities became so pervasive that her card-playing hobby "almost resulted in her majoring in bridge."

After she received her B.S. degree, she moved to Madison, Wisconsin and the University of Wisconsin for graduate work in genetics and molecular biology, but she quit after three semesters. She was uncertain about this field of study and felt that she was not ready for the pressures of graduate school. It was then that she returned to her native Denver where job-hunting was tough. It took six months to find her current job.

For Ms. Dieter, research is exciting and intellectually stimulating, although, she points out, "It is not as romantic as I originally envisioned." Besides the intellectual challenge, she feels her work allows considerable freedom to schedule her hours and to be creative and innovative.

When she was 18, she almost married, but decided not to do it. As she describes it, "It was the first step towards learning to love myself and learning, if I didn't, there was nothing to give anyone else." In addition she thinks it is important for every person to be able to financially support him- or herself. She emphasizes: having a career, not just a job, can make working for a living very interesting."

Today, although her family lives in the same city, she has her own apartment, which she shares with two "dependents" — her two cats — whom she describes as "alley variety". And once again, she is contemplating marriage to a man who does research in the same laboratory.

EDUCATION: B.S., 1972, Willamette University, Salem, Oregon
Graduate work in Genetic and Molecular Biology, University of Wisconsin
Graduate work in Biology, University of Colorado

Sonia Navia Gitlin, Chemist

Support Scientist, National Center for Atmospheric Research, Boulder, Colorado

A Swedish mother who was an actress and a Spanish father who was a businessman are part of the international heritage of Sonia Navia Gitlin, who grew up in Argentina. This heritage is the reason that Ms. Gitlin loves literature and music and speaks several languages. Her father died when she was eight years old. leaving her mother to raise her and her brother alone and there was not enough money to provide for college educations. Therefore, although Ms. Gitlin had an early interest in science, she did not expect to go to college. Instead, she took a secretarial position which allowed her to use her language translation skills.

When she was in her early thirties, a prolonged illness gave her time to rethink her future. Science was still high on her list, so she decided to attend college and study chemistry. The lure of the American West proved irresistible and she was accepted at the University of Colorado. It was while there, in her sophomore year, that Ms. Gitlin met and married her husband. That was 23 years ago. They are still married today and their two boys have grown and gone away to college.

Ms. Gitlin's college training was very important to her, so that, despite having a family, she continued into graduate school, juggling her studies with the care of her then young children. She says, "It is not easy to have two full-time roles: career woman and homemaker and mother. Although my husband supports my view in theory, it does not always work so well in practice." But, she would not have it otherwise because, as she points out, "It gives me a chance to fulfill my intellectual needs."

After she received her masters degree, she thought of going on for a Ph.D. degree, but further family responsibilities, including her mother's illness, prevented her from doing so. When the demands of her family lessened, she took a job with a National Center for Atmospheric Research, where she has been for the past sixteen years.

EDUCATION: B.S. Chemistry, 1959, University of Colorado at Boulder
M.A. Physical Chemistry, 1966, University of Colorado at Boulder

Dr. Margaret (Peggy) LeMone, Atmospheric Scientist

Ph.D. Scientist
National Center for Atmospheric Research, Boulder, Colorado

When Dr. LeMone, the youngest of four children (three brothers), was a young girl, she dreamed of being many things. In first grade, she was a nurse. In second grade, she was a firefighter. But, by the time she entered seventh grade, she became a meteorologist,since her interest in weather forecasting had already developed. In fact, she thought her native Missouri was so interesting that she kept weather records; the earliest ones consisted of drawings of clouds. She liked to draw then, and she still does today. Her hobbies include sketching and cartooning.

Her interest in weather received further encouragement from several directions, starting with a fifth grade teacher who told her that she had a very exciting future, and a meteorologist in the local weather bureau. She also was encouraged by her older brother, Charlie. After Dr. LeMone's father died, her mother worked outside of the home and her older brother became a parent in residence. He shared her interest in science and treated her "as if she were some kind of a genius." She also learned something else in that part of her life — the need to have a vocation and to be able to earn one's own living.

During Dr. LeMone's early school years, although she liked her art and physical education courses, her interest in science advanced as her mathematics and physics courses advanced. Therefore, after high school, she chose to study mathematics. She points out, though, that the amount of mathematics and science which she studied is not necessary for all phases of meteorological work. It was her personal preference, particularly since she aspired to the research aspects of meteorology. In graduate school she majored in Atmospheric Sciences.

In 1972 Dr. LeMone began working for the National Center for Atmospheric Research, a research laboratory that specializes in her line of work. She finds her work challenging and varied. She describes the "glamour" part,which includes travel and meeting people from all over the world, but she also describes the other challenging, yet frustrating, part,which includes taking the results of her experiments and data collection and analyzing these to learn what is really happening in the atmosphere. It is the latter which requires patience, persistence, and painstaking attention to detail and accuracy, which are important requirements for all scientific work.

Two years ago, Dr. LeMone married a fellow scientist whom she met at her laboratory. They are looking forward to their first child in 1979 when Dr. LeMone expects to combine parenting, another challenging career, with her science. She thinks that she will continue to work part time because she feels that complete absence, over an extended period of time, will make it difficult for her to keep in touch with her profession.

EDUCATION: A.B. Mathematics, 1967, University of Missouri-Columbia
Ph.D. Atmospheric Sciences, 1972, University of Washington, Seattle

Georgia Pedro, Environmental Engineer

District Sanitarian
U.S. Public Health Service, Santa Fe, New Mexico

Her high school counselor told her that she would never make it through engineering school. While she was in engineering school, another counselor told her that she would never graduate. She did not have enough high school mathematics. With all this discouragement, it is surprising she did graduate from engineering school. But it was what she wanted, and perhaps these counselors did not count on Georgia Pedro's persistence and determination. She was the first to enter and graduate from the New Mexico Institute of Technology's new field of environmental engineering.

A few years later she was invited to speak about her work at that same college to visiting high school students. Her only disappointment was not seeing that counselor. She wanted to let him know that she had "made it".

When Ms. Pedro, the oldest child in her family, was a little girl living at the Laguna Indian Pueblo in New Mexico, she waited with anticipation, for her grandfather's return from his field work. He worked in the geology department of the Anaconda Company and he always brought "such interesting things" back with him — rocks, fossils, etc. Her grandfather's influence and her liking for mathematics contributed to Ms. Pedro's desire to try engineering. She wasn't certain what kind and she didn't know much about it, but it seemed right to her.

Today, Ms. Pedro is a commissioned officer in the U.S. Health Service, working as District Sanitarian in the Indian Health Service in New Mexico. She travels throughout her district, providing assistance to 14 Indian tribes. Her job includes supervision of other environmental health personnel, including field sanitarians and environmental health technicians. She works mainly in rural areas, doing, for example, health and sanitation inspections, planning water and sewer systems for the reservations, orienting public health nurses, conducting rabies clinics, and other duties related to environmental health.

Ms. Pedro grew up at the Laguna Pueblo. Five years ago, she married her husband, Vincenti, who came from the same Indian reservation. They went to high school there together. They have a five year old daughter. As Ms. Pedro puts it, "I got my MRS, MPH, and MOM all in the same year."

EDUCATION: B.S. Environmental Engineering, 1970, New Mexico Institute of Technology
MPH Environmental Health Sciences, 1973, University of California-Berkeley

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Dr. Agnes Stroud Schmink, Radiation Biologist

Senior Staff Member, Los Alamos Scientific Laboratory
Los Alamos, New Mexico

"This teacher in seventh grade did something with test tubes. I'm not sure what, but I remember that it was fascinating." Agnes Stroud Schmink wanted to do that too. "My older sisters encouraged me to follow in their footsteps and learn typing, but I didn't care for it. I really wanted to know what made things work."

Dr. Stroud grew up in New Mexico, where her parents were both teachers at the Indian School in Albuquerque. Her father was an American Indian from the Tewa Tribe, Santa Clara Pueblo. She was the fourth of five children. Her parents always taught them to seek higher education or training for a career so that going to college was a natural choice.

While Dr. Stroud was in college, she almost started a career other than the one she planned in biology. Jacqueline Cochrane, the famed woman pilot, started a pilot training school in New Mexico to prepare women for the World War II war effort. Pilots were needed to taxi airplanes into the war zone in England. Dr. Stroud trained at that school, but the war ended before she completed her training and she never used her pilot certificate in the war effort.

After college graduation, Dr. Stroud began working at Los Alamos Scientific Laboratory. She tested blood from people working at the laboratory to check for possible radiation effects. One of those people was Enrico Fermi, the famous nuclear physicist who won the Nobel Prize for his work. He encouraged her to come to the University of Chicago where he taught and to continue her scientific training. Thus, she began the 21-year period of her life which ultimately lead to her Ph.D. degree in biological sciences and to her expertise in the field of radiation biology. A radiation biologist studies the effects of radiation on living cells.

In addition to graduate school, Dr. Stroud worked at Argonne National Laboratory, where she met her first husband, a biomathematician. Within a few short years after their marriage, her husband died, leaving her with a two-year-old daughter and incompleted graduate studies. With a full-time job and a child, Dr. Stroud took 14 years to reach her goal. However, she not only received a Ph.D. degree, but she won the A. Cressy Morrison Prize in natural sciences from the N.Y. Academy of Sciences. She also remarried at that time.

It was then that she and her new husband began to look for a warmer climate, and decided to move to California, where she worked at the Jet Propulsion Laboratory using, according to Dr. Stroud, the "spaceage technology to study chromosomes."

Another six years would go by before, as Dr. Stroud says, she was able to "make the full circle". She returned to her native New Mexico and to Los Alamos Scientific Laboratory, where she continues her research on the effects of radiation on the cells of animal tissue, particularly the chromosomal effects.

Her active, busy life includes tennis and golf. She uses her tennis-playing abilities to raise money for charity. Her other hobbies include oil and watercolor painting and stamp collecting. She is especially interested in encouraging young girls to consider scientific careers, but she also feels it is important to train boys to accept women in these careers because, as she sees it: "There still prevails the negative attitude of men against women when women are competing with them . . . Until parents teach their sons that women are their equals, this attitude will prevail."

EDUCATION: B.S. Biology, 1945, University of New Mexico
Ph.D. Biological Sciences, 1966, University of Chicago

Dr. Judith Anne Harris Van Couvering, Paleontologist

Assistant Professor of Geological Sciences and
Curator of Fossil Vertebrates, University of Colorado, Boulder

Dr. Van Couvering thought that she would be a secretary; therefore, in high school, she took a business course. But, just in case, she also took college preparatory courses. It is fortunate that she did because the opportunity to go to college did occur. She began as a psychology major, but a chance meeting at a party with a young geologist changed the course of her life. She switched majors to paleontology and she married the geologist, embarking on a hectic life which included raising four children while earning a bachelor's degree in paleontology, a Ph.D. degree in geology, and living in Africa and England.

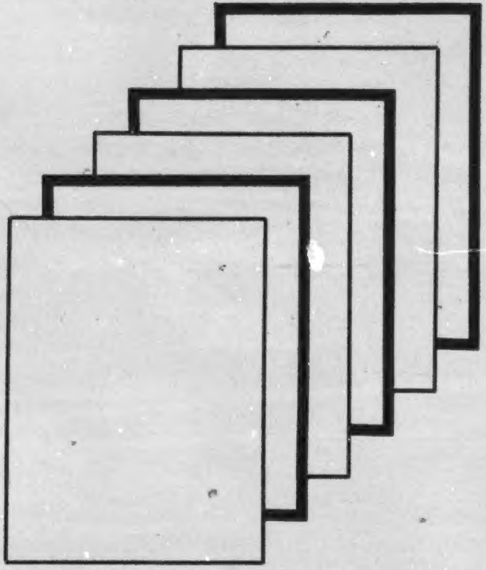
Dr. Van Couvering considers Louis Leakey, the famous anthropologist, a major influence in her life. In another chance event she attended Leakey's lecture in California and learned that he needed a geologist for his expedition to Africa. She just happened to know one. When she suggested to her husband that he might be that geologist, he agreed and interviewed for the job while driving Leakey to the airport. Leakey also agreed. Her husband got the job and the Van Couverings moved to Africa.

After their African work, both husband and wife followed Leakey to Cambridge, England to work on their Ph.D.'s in geology, with her specializing in fossil vertebrates. This resulted in another research project in Africa,which Dr. Van Couvering describes as somewhat chaotic,since all of her children were there to help. It is fortunate that children like to dig.

The next episode in Dr. Van Couvering's life brought her to the University of Colorado in Boulder, where she now teaches advanced vertebrate paleontology and is curator of fossil vertebrates at the university's Natural History Museum. The museum work includes doing research, taking care of the fossil collection, and forming new collections. She enjoys her work, and considers one positive aspect to be the opportunity to wear old clothes and get dirty. She thinks it is a rewarding field, especially for women. According to Dr. Van Couvering, "You can put a lot of different parts of yourself into it if you are creative."

She also observes that "women . . . tend to be more whole people, or at least, desire to live with their whole selves." She feels that "this should be of great benefit to science because it leads to creativity rather than just technology." In her opinion, "the more women in the field the better it will be for men, women, and science."

EDUCATION: B.A. Paleontology, 1960, University of California-Berkeley
Ph.D. Geology, 1972, University of Cambridge, Cambridge, England



RESOURCE MATERIALS

Dear Educator,

Although materials related to women in science are not voluminous, many do exist, if one is willing to look in some likely, and some unlikely, places—libraries, bookstores, and publication lists of professional organizations. In this bibliography, the emphasis is on materials which the educator can offer to the student. There are some very fine journal articles and research papers about sex differences and the sciences, but they are not appropriate to this bibliography. However, some bibliographies and some resources are included that do list these documents to assist you in your own background reading.

The resources listed herein are annotated and classified. The level at which they can be used is also indicated. For the purpose of this section, the levels are given as:

PR — primary (grades K-3)

IN — intermediate (grades 4-6)

JH — junior high (grades 7-9)

SH — senior high (grades 10-12)

As you review and use this section, you might observe that materials on the medical profession seem to be heavily represented. This is due to the availability and amount of materials on women in medicine. A case in point is Elizabeth Blackwell. The drama and excitement of women opening up the medical profession appears to be a subject of continuous fascination to writers, biographers, and to the female main characters themselves. Thus, in the case of biographies of the early women doctors, it was necessary, due to length alone, to offer a selection rather than list them all.

Books about women scientists are very scarce at the primary level; the majority of those listed are in the fiction section. Of those few, The Newbery Award-winning, A WRINKLE IN TIME, and the MISS PICKERELL series are worthy of special mention.

Your students and you should find these materials enjoyable and informative.

Sharon L. Menard

FICTION

Brenner, Barbara. THE FLYING PATCHWORK QUILT PR
Young Scott Books, 1965

Five-year-old Ellen tries to fly using an umbrella, paper wings, and balloons. She finds an old patchwork quilt which she pins around her neck and jumps from the dog house and soars into the air.

Chenery, Janet. WOLFIE PR
Harper & Row, 1969; A Science I Can Read Book

A little girl attempts to see her brother's pet wolf spider. Contains some accurate scientific details about spiders.

Clark, Ann Nolan. ALONG SANDY TRAILS IN
Viking Press, 1969

A Papago Indian girl is told about the wonders of her desert home in this beautifully illustrated book.

Cole, Joanna. PLANTS IN WINTER PR
Crowell, 1973

A botanist explains to her young friend the different ways that plants are protected through cold weather. Provides a woman as a role model for a boy. Beautiful watercolor illustrations.

Danish, Barbara. THE DRAGON AND THE DOCTOR PR
Feminist Press, 1971

A woman doctor cures an ailing dragon.

Engdahl, Sylvia. ENCHANTRESS FROM THE STARS JH
Atheneum, 1970

A young girl from an advanced civilization must prove her worth as an anthropologist while exploring a planet similar in culture to Earth's middle ages.

Engdahl, Sylvia. FAR SIDE OF EVIL JH
Atheneum, 1971

In this sequel to ENCHANTRESS FROM THE STARS, the same young girl goes on a dangerous mission to save a fledgling civilization.

George, Jean Craighead. JULIE OF THE WOLVES IN
Harper & Row, 1972; A Newbery Medal Winner

Miyax, an Eskimo girl, shows courage, determination, and intelligence while travelling alone on the fringe of a wolf pack. Contains accurate, detailed information on animal life and the Arctic north.

George, Jean Craighead. THE HOLE IN THE TREE PR
E.P. Dutton, 1957

Scot and Paula Gordon, two small children, discover a hole in an apple tree. A scientifically accurate account of birds, insects, and raccoons.

Knotts, Howard. FOLLOW THE BROOK PR
Harper & Row, 1975

Liza, Sam, and Addie follow a brook near their home and act like real children as they explore its changing face. This is a good book to use in a unit on the senses and also one to read before a field trip to a stream or river.

L'Engle, Madeleine. A WRINKLE IN TIME IN-JH
Farrar, Straus, & Giroux, 1962; Newbery Medal Winner
(Also available in Yearling edition)

This is a tale of outer space, one of the few science fiction books with a girl, Meg, as a main character. It may be the only children's book in which mother is a brilliant scientist. Some insights into mathematical concepts.

L'Engle, Madeleine. A WIND IN THE DOOR IN-JH
Farrar, Straus, & Giroux, 1976

This sequel to A WRINKLE IN TIME features the same characters, except this time the Murry family goes from the large cosmic outer spaces (in WRINKLE) to the super-microscopic inner spaces of Meg's young brother to save his life.

Lenthall, Patricia Riley. CARLOTTA AND THE SCIENTIST PR
Lollipop Power, 1973

Carlotta the penguin leaves her husband warming her egg while she and other female penguins go fishing. Her curiosity leads her into an adventure with a woman scientist.

MacGregor, Ellen, and Pantell, Dora. THE MISS PICKERELL BOOKS IN
McGraw-Hill/Whittlesey House

Miss Pickerell is a lively, independent-minded woman. She has an uncanny knack for finding unusual problems and situations which require unusual solutions, persistence, and courage, all of which Miss Pickerell has, along with a fond attachment for her cow. Each book in the series introduces scientific topics in an uncomplicated, yet detailed, way.

MISS PICKERELL GOES TO MARS
1951

While taking a trip to Mars (which is not an uncommon thing for Miss Pickerell to do), she learns about gravity, atmospheric pressure, planetary orbits, and rocket ships. She begins her famous rock collection with specimens from Mars.

MISS PICKERELL AND THE GEIGER COUNTER
1953

In this adventure, Miss Pickerell learns about atomic energy and radioactivity.

MISS PICKERELL GOES UNDER THE SEA
1953

Miss Pickerell nearly loses her rock collection. In the process of getting it back, she learns about sonar, atomic-powered submarines, under water television, deep-sea diving, and the continental shelf.

MISS PICKERELL GOES TO THE ARCTIC
1954

Miss Pickerell goes to the rescue in the Arctic while the reader finds out about glaciers, ice shelves, Arctic conditions, the midnight sun, weather, the tundra, permafrost, and a shortwave radio.

MISS PICKERELL ON THE MOON
1965

When Miss Pickerell's cow needs medicine, she goes all the way to the moon on a space shuttle. On the way, she learns about antibiotics, vaccines, sunstorms, gravity, and the moon.

MISS PICKERELL GOES ON A DIG
1966

Miss Pickerell's adventure in archeology brings her information on carbon-dating, geology, and the earth's soil layer.

MISS PICKERELL HARVESTS THE SEA
1968

As Miss Pickerell descends to the ocean's depths, the reader learns about deep-sea diving and oceanography and enters the fascinating world of marine life.

MISS PICKERELL AND THE WEATHER SATELLITE
1971

When the weatherman's predictions don't make sense, Miss Pickerell's determination leads her to learn about computers, weather forecasting, weather satellites, lasers, weather communications systems, and solar energy.

MISS PICKERELL MEETS MR. HUM
1974

The machines will not take over with Miss Pickerell to contend with. The reader learns about computer systems, programming, and robots. There is even a scientific conference chaired by a woman referred to as "Ms. Chairlady"!

MISS PICKERELL TAKES THE BULL BY THE HORN
1976

Miss Pickerell's concern for her cow leads her to learn about genetic engineering, heredity, genes, chromosomes, and DNA. In this adventure she rides on a motorcycle with a woman who is the assistant sheriff.

MISS PICKERELL TO THE EARTHQUAKE RESCUE
1977

Miss Pickerell's concern for people and her beloved Square Toe Territory causes her to invade a cave and the earth's depths to investigate some secret experiments. The reader is introduced to earthquakes and their causes, seismographs, faults in the earth's crust, and the Richter scale.

Mannheim, Grete. THE VETERINARIAN'S CHILDREN IN
Alfred A. Knopf, Inc., 1971

The son and daughter of a veterinarian help him in his work and take equal responsibilities.

Merril, Judith. DAUGHTERS OF EARTH IN
Doubleday

The title is the first of three science fiction stories. It shows women astronauts on equal footing with men.

North, Joan. THE LIGHT MAZE IN-JH
Farrar, Straus, & Giroux, 1971

A complex, suspenseful science fiction tale with a determined young girl and a thoughtful young woman as main characters.

Rockwell, Anne. SALLY'S CATERPILLAR IN
Parents Magazine Press, 1966

Finding a caterpillar is an exciting end-of-summer event for Sally. Her parents help her care for it until it becomes a very lovely butterfly. In this simple story, we meet a competent mother, a nurturing dad, and a young girl who is interested in science. She, at one point, even goes into a milkweed patch to find a snake.

Rockwell, Anne and Harlow. MOLLY'S WOODLAND GARDEN PR-IN
Doubleday, 1971

Molly watches something very unusual "sprout" from the woodland garden where she planted beans.

Rockwell, Harlow. MY DOCTOR PR
Macmillan, 1973

Child narrates the story of his visit to his doctor. All the instruments are explained to him as she uses them to examine him. The instruments are well-illustrated.

Sargent, Pamela, editor. WOMEN OF WONDER. MORE WOMEN OF WONDER ADULT
Vintage Books, 1975; 1976

Two collections of science fiction stories by and about women. Excellent selections for a women's studies science fiction course.

Selsam, Millicent D. MORE POTATOES! PR
Harper & Row, 1972; A Science I Can Read Book

Sue persistently questions everyone about potatoes until she has engineered a visit to the grocer in time to see a wholesaler doing his work. Then, there follows class trips to a warehouse and a farm.

Selsam, Millicent E. TERRY AND THE CATERPILLARS PR
Harper & Row, 1962; A Science I Can Read Book
(Available in a Spanish language edition)

A little girl learns about the moth's life cycle by caring for three butterflies.

Thayer, Jane. QUIET ON ACCOUNT OF DINOSAUR PR
Morrow, 1964

A little girl finds a dinosaur and brings it to school where she can study it. When she grows up, she becomes a famous scientist who "knows more about dinosaurs than anyone else in the world."

Young, Miriam. SLOW AS A SNAIL, QUICK AS A BIRD IN
Lothrop, Lee, & Shepard, 1970

An appealing tale of a young girl's awakening interest in the creatures of her natural surroundings. The main theme is an accurate and imaginative description of a caterpillar's metamorphosis into a monarch butterfly. Sketches are attractive, accurate, and appropriate.

Wolde, Gunilla. TOMMY GOES TO THE DOCTOR PR
Houghton-Mifflin, 1972

Tommy's doctor uses her instruments for his examination; Tommy does the same with his teddy bear.

NONFICTION

Shalit, Nathan. CUP AND SAUCER CHEMISTRY IN
Grosset & Dunlap, 1974
(Available in paperback)

Illustrations feature both a boy and a girl in active roles. The simple experiments can be done at home without a chemistry set or expensive equipment.

BIOGRAPHIES

The following biographies are listed in alphabetical order by subject.

ELIZABETH GARRETT ANDERSON

Anderson, Louisa Garrett. ELIZABETH GARRETT ANDERSON JH-SH
Faber, 1939

In 1865, Anderson became the first English woman licensed to practice medicine. This biography was written by her daughter.

Monton, Jo. ELIZABETH GARRETT IN
Abelard, 1960

This biography shows how Anderson (Garrett) devoted her life to helping women. The introduction includes a summary of the contributions of woman doctors to English medicine.

ISABEL BARROWS

Stern, Madeleine B. SO MUCH IN A LIFETIME JH
Messner, 1964

This is the story of the first woman eye specialist who was also the first woman to be a private secretary to the U.S. Secretary of State.

ELIZABETH BLACKWELL

Baker, Rachel. THE FIRST WOMAN DOCTOR JH
Messmer, 1944

Fictionalized story of the first woman admitted to a U.S. medical school.

Chambers, Peggy. A DOCTOR ALONE SH-ADULT
Abelard-Schuman, 1958

Covers Blackwell's early childhood in Bristol, England and her struggles to enter medical school and to start a medical practice. Well-written and documented. Includes information on the social and political situation at various times in Blackwell's life.

Clapp, Patricia. DR. ELIZABETH IN-JH
Lothrop, Lee, & Shepard, 1974

For young readers.

Hays, Elinor Rice. THOSE EXTRAORDINARY BLACKWELLS IN-JH
Harcourt Brace, 1967

Story not only of Elizabeth, but also of her sister Emily, who followed her sister's footsteps. Emily became a physician and joined Elizabeth in their New York Infirmary.

Heyn, Leah Lurie. CHALLENGE TO BECOME A DOCTOR IN-JH
Feminist Press, n.d.

Easy-to-read biography with 32 period prints and many drawings.

Latham, Jean Lee. ELIZABETH BLACKWELL: PIONEER DOCTOR PR
Garrard, 1975; A Discovery Book

Illustrated.

McFerran, Ann. ELIZABETH BLACKWELL: FIRST WOMAN DOCTOR JH-SH
Grosset

For older readers.

Wilson, Dorothy Clarke. LONE WOMAN: THE STORY OF ELIZABETH BLACKWELL ADULT
Little, Brown, 1970

This is a comprehensive, in-depth biography. Well researched.

RACHEL CARSON

Brooks, Paul. THE HOUSE OF LIFE: RACHEL CARSON AT WORK ADULT
Houghton-Mifflin, 1972

This biography is also a collection of Carson's writings. Carson's books established her as the most eloquent conservationist in recent history. It traces her early struggles, her disappointments, and the triumphs which led to her central position in a storm of controversy.

Latham, Jean Lee. RACHEL CARSON: WHO LOVED THE SEA IN
Garrard, 1973

An easy-to-read, inspiring book.

Sterling, Philip. SEA AND EARTH: THE LIFE OF RACHEL CARSON IN-JH
Crowell, 1970

An ardent naturalist, Carson kindled imagination with two best selling books: THE SEA AROUND US and SILENT SPRING.

NINA CASE

Wheeler, Shirley. DR. NINA AND THE PANTHER SH-ADULT
Dodd, Mead, & Co., 1977
Paperback edition; Bantam Books, 1978

Story of a remarkable Pennsylvania woman doctor whose career and independence were oddities at the time. A well-written, amazing narrative by her daughter.

RESOURCE MATERIALS

MARIE CURIE

Curie. Eve. MADAME CURIE ADULT
Doubleday, Diran, & Co., 1937
(Translated by Vincent Sheehan)

Comprehensive biography of the Nobel Prize-winning scientist by her younger daughter drawn from published and unpublished records and from personal remembrance.

Doorly, Eleanor. THE RADIUM WOMAN IN-JH
Roy Publishers, 1965

Detailed story particularly concerned with Curie's scientific work. Very good coverage of her early experiments with uranium. Also shows the effect of her personal life on her work and her persistence and determination.

Eberle, Irmengarde. RADIUM TREASURE AND THE CURIES JH
Crowell, 1942

This book is about both Marie and Pierre Curie. It contains detailed information about radium and the medical uses of radioactivity. Also contains a chapter about the daughters of the Curies, Irène and Eve. Irène, who worked as her mother's assistant, won a Nobel Prize.

Henriod, Lorraine. MARIE CURIE PR
Putnam, 1970; A See and Read Beginning Biography

Illustrated.

Henry, Joanne Landers. MARIE CURIE: DISCOVERER OF RADIUM PR-IN
Macmillan, 1966; Science Story Library

Simplified for young readers.

Ivimey, Alan. MARIE CURIE: PIONEER OF THE ATOMIC AGE IN-JH
Praeger, 1969

For older readers.

McKown, Robin. MARIE CURIE IN-JH
Putnam, 1971; A World Pioneer Biography

An intimate protrait of a shy, humane, brilliant scientist.

Reid, Robert. MARIE CURIE SH-ADULT
Saturday Review Press/E.P. Dutton, 1974
(Available in paperback)

This is an excellent, detailed, serious account of Curie. Includes photographs.

Rubin, Elizabeth. THE CURIES AND RADIUM JH
Franklin Watts, 1961

Provides a good explanation for young readers of radioactivity (alpha, beta, and gamma rays), laboratory work of the Curies, radium treatment for tumors and cancer. Also includes the work of Irène Curie and Frédéric Joliet.

Thorne, Alice. THE STORY OF MADAME CURIE JH
Grosset & Dunlap, 1959

Somewhat fictionalized, this story tells of Curie's early years in Poland, her studies in Paris at the Sorbonne, her work with radioactivity, and her many firsts.

ANNA DANIELS

Singer, Joy Daniels. MY MOTHER, THE DOCTOR SH-ADULT
E.P. Dutton, 1970

A lighthearted story about a Russian immigrant Jewish family who came to America around the turn of the century. This personal recollection by Daniel's daughter provides insight into Jewish culture and humor, although there is little scientific information.

ALICE EASTWOOD

Wilson, Carol Green. ALICE EASTWOOD'S WONDERLAND: THE ADVENTURES OF A BOTANIST
California Academy of Science, 1955

Traces the life of Eastwood, curator of a herbarium in Golden Gate Park in San Francisco. She directed the botannical section of the California Academy of Science. A grove of California redwoods is named for her.

ROSALIND FRANKLIN

Sayre, Anne. ROSALIND FRANKLIN AND DNA ADULT
W.W. Norton, 1975
(Available in paperback)

This book is subtitled: "A vivid view of what it is like to be a gifted woman in an especially male profession", which it is. The author, a friend of Franklin, states that it is not a biography. It is actually more. It is an insightful, complex look into the scientific work with particular emphasis on Franklin and the complexities of the politics and personalities which were involved in the discovery of DNA, the fundamental molecules of life. This discovery led to the awarding of the Nobel Prize to three men in 1962. Franklin, who died at the age of 37, was not included in the award-winning group. This book, which carefully traces sex discrimination in the scientific community, is a mature treatment of the subject. Well worth reading, especially for those who are serious about science.

ALICE HAMILTON

Grant, Madeleine. ALICE HAMILTON: PIONEER DOCTOR IN INDUSTRIAL MEDICINE JH
Abelard-Schuman, 1967

Hamilton's work to provide a safe, healthful working environment for U.S. workers made her a pioneer in her field.

IRENE JOLIET-CURIE

McKown, Robin. SHE LIVED FOR SCIENCE IN-JH
Messner, 1961

A biography of the daughter of Marie and Pierre Curie. With her husband, Frédéric Joliet, she won a Nobel Prize for the discovery of artificial radioactivity. An inspiring, well-researched account.

LISE MEITNER

Crawford, Deborah. LISE MEITNER: ATOMIC PIONEER JH
Crown, 1969

Lise Meitner was an Austrian physicist whose research led to the splitting of the atom. Little treatment of scientific matters.

MARIA MITCHELL

Baker, Rachel & Merlin, Joanna Baker. AMERICA'S FIRST WOMAN ASTRONOMER IN
Messner, 1960

Tells of Mitchell's discovery of a comet and provides information on various aspects of astronomy. Concentrates on her teens and her intensely religious upbringing. Illustrates life in a New England seaport in the 1800's.

Melin, Grace Hathaway. MARIA MITCHELL: GIRL ASTRONOMER IN
Bobbs-Merril, 1954; Childhood of Famous American Series

Story of Mitchell's early school years, showing her as a persistent, high-spirited girl who loved star gazing and who was good at mathematics. Includes some information on constellations and celestial navigation.

Wilkie, Katherine. MARIA MITCHELL: STARGAZER IN
Garrard, 1966

For young readers.

Wright, Helen. SWEEPER IN THE SKY IN-JH
Macmillan, 1949

Emphasizes Mitchell's work in women's rights and women's education.

BETHENIA OWENS-ADAIR

Miller, Helen. WOMAN DOCTOR OF THE WEST JH
Messmer, 1960

Bethenia Owens-Adair fought prejudice and ridicule to become a great physician and brilliant surgeon. This is a lively story of a pioneer woman who was one of the few women practicing medicine in the Pacific Northwest before the turn of the century.

HELEN PERLEY

Johnson, Eleanor Noyes. MRS. PERLEY'S PEOPLE IN
Westminster, 1970

Her scientific investigations, begun in childhood, have made Perley a respected authority on animal life.

FLORENCE SABIN

Bluehmel, Elinor. FLORENCE SABIN: COLORADO WOMAN OF THE CENTURY SH-ADULT
University of Colorado Press, 1959

Biography of the first woman to serve on the faculty of Johns Hopkins University Medical School. Her early life in Colorado and her many achievements are well described.

Phelan, Mary Kay. PROBING THE UNKNOWN IN
Crowell, 1969
(Available in paperback)

In a day when few women considered careers, Dr. Sabin excelled in three — teacher, scientist, and public health inspector.

ELLEN RICHARDS SWALLOW

Douty, Esther M. AMERICA'S FIRST WOMAN CHEMIST JH-SH
Messner, 1961

The story of the first woman to study at Massachusetts Institute of Technology. It shows her struggle for an education and her development of home economics.

Hunt, Caroline. ELLEN RICHARDS SH
Whitcomb & Barrows, 1912

Written about Richards (Swallow) in her lifetime.

MARY WALKER

Synder, Charles. DR. MARY WALKER: THE LITTLE LADY IN PANTS SH-ADULT
Vantage Press, 1962; Arno Press (reprint), 1974

Controversial Dr. Walker rebelled against convention. Her insistence on wearing men's clothes made her a target for her critics while she was an assistant army surgeon during the American Civil War. She won the Congressional Medal of Honor for her service, but Congress later withdrew it in 1917.

BIOGRAPHIES — COLLECTIONS

Bolton, Sarah. LIVES OF GIRLS WHO BECAME FAMOUS IN
Crowell, 1949

Includes biographies of Elizabeth Blackwell, first woman to receive a medical degree in the United States; and Marie Curie, discoverer of radium and Nobel Prize winner.

Bowman, Kathleen. NEW WOMEN IN MEDICINE IN-JH
Creative Education/Children's Press, 1976
123 Broad St., Mankato, Minn. 56001

Biographical sketches of living women doctors with understandable information about their work. This attractive,well-written book is illustrated with photos of Mary Calderone, Kathryn Nichol, Anna Ellington, Mary Louise Robbins, Estelle Ramey, Margaret Hewitt, and Elisabeth Kübler-Ross.

Boynich, David K. PIONEERS IN PETTICOATS IN
Crowell, 1959

Includes biographies of Lillian Gilbreth, engineer, and Alice Hamilton, physician.

Clymer, Eleanor. MODERN AMERICAN CAREER WOMEN IN
Dodd, Mead, 1964

Includes biographies of Lillian Gilbreth, engineer, and Helen Taussig, physician, whose research on blue babies led to a lifesaving surgical technique.

Dash, Joan. A LIFE OF ONE'S OWN: SH-ADULT
THREE GIFTED WOMEN AND THE MEN THEY MARRIED
Harper & Row, 1973

Includes biography of Maria Goeppert-Mayer, starting on page 229 where her picture appears. Goeppert-Mayer won a Nobel Prize for her work in theoretical physics on the "shell theory" of the atom. This is an intimate, human portrait of a great scientist who juggled a professional scientific career with family and marriage, and who was a colleague of some of the world's greatest modern scientists.

Diamonstein, Barbaralee. OPEN SECRETS: 94 WOMEN IN TOUCH WITH OUR TIME JH-SH-ADULT
Viking Press, 1972

This is not a biographical collection, but rather a compendium of the results of questionnaires sent to notable women in all fields of endeavor. The woman scientists include: Virginia Apgar, M.D., the first woman full professor at Columbia Medical School; Nina Braunwald, M.D., thoracic surgeon and specialist in open heart surgery; Katherine Bourot Sturgis, M.D., specialist in epidemic research and pulmonary disease; Helen Taussig, M.D., who won the Presidential Medal of Freedom; and Beatrice Willard, conservationist and pioneer ecologist.

Emberlin, Diane. CONTRIBUTIONS OF WOMEN: SCIENCE IN-JH-SH
Dillon Press, 1977

Part of a series of books on women which features biographies of women in various fields. Brief biographies of women scientists including Annie Jump Cannon, Lillian Gilbreth, Margaret Mead, Rachel Carson, Ruth Patrick, and Eugenie Clark. Additional women are listed in the appendix. Photos included.

Feminists Northwest. HYPATIA'S SISTERS IN-JH-SH
5038 Nicklas Place, NE, Seattle, Washington 98105
1976

Biographies of women scientists, past and present.

Fleming, Alice. DOCTORS IN PETTICOATS JH
Lippincott, 1964

Biographies of ten women who fought to establish the right to a medical career and who also made advances in medicine. Includes Marie Zakrzewska, Mary Putnam Jacobi, Emily Dunning Barringer, Clara Swain, Alice Hamilton, Louise Pearce, Sara Jordan, Karen Horney, Leona Baumgartner, and Connie Mayers Guion.

Gersh, Harry. WOMEN WHO MADE AMERICA GREAT IN
Lippincott, 1962

Brief biographies of important women engaged in a variety of careers, including engineering and astronomy.

Hacker, Carlotta. THE INDOMITABLE LADY DOCTORS SH-ADULT
Clarke, Irwin, & Co., 1974

Golden Jubilee project of Federation of Medical Women of Canada. This is the story of Canada's pioneer doctors including pictures. In 1874, no women were licensed to practice in Canada. Today, 4,000 women practice medicine in Canada. It is an entertaining book. Highly readable.

Hayden, Robert C. & Harris, Jacqueline. NINE BLACK AMERICAN DOCTORS IN-JH
Addison-Wesley, 1976

Includes biographies of two women with their photos. Jane Wright is called the enemy of cancer. She received the Finer Womanhood award as part of the International Women's Year celebration at Clark College in Atlanta, Ga. Angela Ferguson has done research on sickle cell anemia.

Hoyt, Mary Finch. AMERICAN WOMEN OF THE SPACE AGE IN-JH
Atheneum, 1966

Brief survey including biographies of women scientists, computer experts, research physicians.

Hume, Ruth Fox. GREAT WOMEN OF MEDICINE JH-SH
Random, 1964

A lively account of women doctors and other medical trailblazers, including Mary Putnam Jacobi, Sophia Jex-Blake, Elizabeth Blackwell, Elizabeth Garrett Anderson, and Marie Curie. This book shows the influence that Blackwell had on other women in her time. Includes a special chapter on women in medicine in the twentieth century.

Lutzker, Edythe. WOMEN GAIN A PLACE IN MEDICINE JH-SH
McGraw-Hill, 1969

The story of the five courageous young women who fought to open the doors of medical education to qualified female students. At the University of Edinburgh, Sophia Jex-Blake, Edith Pechey, Isabel Thorne, Matilda Chaplin, and Helen Evans faced opposition and insults to become licensed physicians.

RESOURCE MATERIALS

Merriam, Eve. GROWING UP FEMALE: TEN LIVES SH-ADULT
Dell Publishing, 1971
(Available in paperback)

A collection of diaries, journals, and letters of ten women. Includes the original writings of Maria Mitchell, astronomer, and Anna Howard Shaw, pioneer doctor.

Osen, Lynn M. WOMEN IN MATHEMATICS SH-ADULT
MIT Press, 1974

Biographies of selected women mathematicians. Traces the history of female scholarship in this area from prehistory to the present. The biographies emphasize the intellectual accomplishments made by women despite the prejudices against them.

Perl, Teri. MATH EQUALS SH-ADULT
Addison-Wesley, 1978

Biographies of women mathematicians plus related activities. In addition to reading the biographies, you can try mathematical problems. Included are Hypatia, Emilie du Châtelet, Maria Gaetana Agnesi, Sophie Germain, Mary Fairfax Somerville, Ada Byron Lovelace, Sonya Kovalevski, Grace Chisholm Young, and Emmy Noether.

Seed, Suzanne. SATURDAY'S CHILD JH-SH
Bantam Books, 1973
(Available in paperback)

36 women talk about their jobs. In the Science and Medicine section, eight women are included—a veterinarian, a geologist, a physician, an oceanographer, a pharmacist, a physician's associate, a developmental biologist, and a biophysicist.

Yost, Edna. AMERICAN WOMEN OF SCIENCE JH-SH
Frederick A. Stokes Co., 1943

Collection of biographies of women scientists in the fields of bacteriology and medicine, in refrigeration and industrial engineering, and in chemistry, physics, zoology, botany, astronomy, and anthropology. Included are Hazel Stiebling, Lillian Gilbreth, Katharine Blodgett, Wanda Farr, Alice Hamilton, Mary Pennington, Libbie Hyman, Margaret Mead, Florence Sabin, Florence Siebert, and Ellen Richards Swallow.

Yost, Edna. WOMEN OF MODERN SCIENCE JH-SH
Dodd, Mead, 1959

Biographies of women born before or around 1900, including Gerti Cori (Nobel Prize winner), Lise Meitner, Helen Sawyer Hogg, Elizabeth Shull Russell, Rachel Fuller Brown, Chien-Shiung Wu, Jocelyn Crane, Florence Van Straaten, and Gladys Anderson Emerson.

AUTOBIOGRAPHIES

Baker, S. Josephine. FIGHTING FOR LIFE SH-ADULT
Macmillan, 1939; Arno Press, 1974 (reprint)

Dr. Baker, one of America's pioneer women doctors, relates her personal story. She was a contemporary of Emily Blackwell, sister of Elizabeth Blackwell, who also became a doctor.

Barringer, Emily Dunning. BOWERY TO BELLEVUE SH-ADULT
W.W. Norton, 1950

Subtitled "The story of New York's first woman ambulance surgeon". Barringer covers the youth and early experiences of her life in the early twentieth century.

Blackwell, Elizabeth. OPENING THE MEDICAL PROFESSION TO WOMEN SH-ADULT
Everyman, 1895 (under title of PIONEER WORK FOR WOMEN)
Schocken Books, 1977

Blackwell tells her own story.

Clark, Eugenie. LADY WITH A SPEAR SH
Harper & Row, 1953

Dr. Clark, a scientist who studied fish, talks about her girlhood, education, and first exciting job. Considerable scientific detail. Photos included.

Clark, Eugenie. THE LADY AND THE SHARKS SH
Harper & Row, 1969

Dr. Clark's life during her years at Cape Haze Marine Laboratory. As in her earlier book, abundant detail is included on catching and experimenting with sharks. Her work established her as an international authority on sharks. Photos included.

Clark, Eugenie. ADVENTURE ON THE LAST FRONTIER SH
Ginn & Co., 1970

The continuation of Dr. Clark's life.

Jex-Blake, Sophia. MEDICAL WOMEN: A THESIS AND A HISTORY SH-ADULT
Source Book Press, 1970 (reprint of 1886 edition)

The personal memoirs of Jex-Blake, who led what became known as the "Battle of Edinburgh" to gain admittance for women to the University of Edinburgh Medical School. She includes, as justification for women entering medicine, a history of women as midwives, healers and surgeons. She also presents her rebuttal to the arguments used to exclude women from the medical profession. Also includes the text of the case filed against Edinburgh by the women students.

Kendall, Phebe Mitchell. MARIA MITCHELL: LIFE, LETTERS, AND JOURNALS SH-ADULT
Lee & Shepard, 1896; Books for Libraries Press (reprint), 1971

Compiled from Mitchell's journal and correspondence, with interpretation and linkages provided by Kendall. The book is an intimate, honest, and occasionally witty insight into the personal life of America's well-known astronomer. It includes an account of Mitchell's visit with mathematician Mary Somerville.

RESOURCE MATERIALS

King-Salmon, Frances. HOUSE OF A THOUSAND BABIES SH-ADULT
Exposition Press, 1968

The author writes of her experiences as a physician in China in the period of 1922-1940.

Murray, Florence J. AT THE FOOT OF DRAGON HILL SH-ADULT
E.P. Dutton, 1975

A delightful story of a woman from Nova Scotia who spent two decades in Korea. Includes her capture by the Japanese and subsequent exchange for Japanese prisoners in 1942.

SH-ADULT
Somerville, Martha. PERSONAL RECOLLECTION FROM EARLY LIFE TO OLD AGE OF MARY SOMERVILLE
AMS Press, 1973 (first published in 1874)

The title says it all. Taken from Somerville's personal correspondence. Mary Somerville was an outstanding mathematician in the 1800's.

Vietor, Agnes, editor. A WOMAN'S QUEST SH-ADULT
D. Appleton, 1924; Arno Press (reprint), 1972

Dr. "Zak" was a contemporary of Elizabeth Blackwell and Mary Putnam Jacobi. She immigrated from Germany for the purpose of studying medicine. This is a recent reprint of Marie Zakrzewska's own life story in her own words.

HISTORY

Lovejoy, Esther C.P. WOMEN DOCTORS OF THE WORLD SH-ADULT
Macmillan, 1957

Illustrated with photos. Includes chapters on women in different parts of the world. Lovejoy raises the question: "Is it coincidental that the golden age of medicine occurred with full acceptance of women into the medical profession?"

Marks, Geoffrey & Beatty, William K. WOMEN IN WHITE: THEIR ROLE AS DOCTORS THROUGH THE AGES SH-ADULT
Scribner's, 1972

History of women in the healing arts from the ancient world to 1970, the year which ended the era of exclusively male medical colleges.

Mead, Kate C.H. A HISTORY OF WOMEN IN MEDICINE: FROM THE EARLIEST TIME TO THE BEGINNING OF THE NINETEENTH CENTURY SH-ADULT
Milford House, 1973 (reprint of 1938 edition)

A detailed account of women as healers, physicians, and surgeons from the earliest times into the twentieth century, including most countries in the western world.

Mozans, H.J. WOMEN IN SCIENCE SH-ADULT
MIT Press, 1975 (reprint of 1913 edition)

The introductory chapter is a history of woman's long struggle for access to scientific education and professions. Includes biographical material on women who have made contributions in mathematics, astronomy, physics, chemistry, natural sciences, archaeology, medicine and surgery. Historically valuable as a research reference.

Richardson, Robert S. THE STAR LOVERS SH-ADULT
Macmillan, 1965

A collection of writings from over four centuries. Although primarily about men, it does contain a short chapter on women astronomers entitled "Lady Huggins and Others" with a direct quote from the English astronomer, Lady Huggins, on opportunities for women in astronomy, which sounds as if it could be written today.

BIBLIOGRAPHIES

Carter, Constance. WOMEN IN THE SCIENCES
March, 1976
Lc Science Tracer Bulletin
Reference Section
Science and Technology Division
Library of Congress, 10 First Street, SE, Washington, D.C. 20540

Davis, Audrey B. BIBLIOGRAPHY ON WOMEN:
WITH SPECIAL EMPHASIS ON THEIR ROLES IN SCIENCE AND SOCIETY
Science History Publications, 1974
156 Fifth Avenue, NYC 10010

Roysdon, Christy. WOMEN IN ENGINEERING:
A BIBLIOGRAPHY ON THEIR PROGRESS AND PROSPECTS
Council of Planning Librarians, 1975
Monticello, Illinois

POSTERS

EMINENT MATHEMATICIANS
Springer-Verlang New York, Inc.
175 Fifth Avenue, NYC 10010 ($2.00 per poster)

Posters available of Sonya Kovalevski and Emmy Noether. Size: 20" x 32"

WOMEN IN SCIENCE
J. Weston Walch
Box 658, Portland, Maine 04104 ($6.00 plus $1.15 for shipping)

18 (11" x 14") posters with biographical sketches by Barbara Stanford. Excellent photographs of each woman. Included are Annie Jump Cannon, astronomer; Rachel Carson, conservationist; Gerti Cori, chemist; Maria Goeppert-Mayer, theoretical physicist; Irène Joliet-Curie, physicist; Florence Sabin, medical researcher; Alice Hamilton, research physician; Dorothy Hodgkin, chemist; Jane Goodall, animal behaviorist; Sylvia Mead, marine biologist; Ola Watford, geophysicist, and others.

PERIODICALS

LIFE SPECIAL REPORT: REMARKABLE AMERICAN WOMEN, 1776-1976
Time-Life, Inc. 1976 ($2.00)

Some women scientists included with pictures and biographical information. Included are: Lillian Gilbreth (page 7); Maria Mitchell (page 68); Florence Sabin (page 68); Maria Goeppert-Mayer (page 69); Grace Hopper (page 68); Chien-Shiung Wu (page 68); Helen Taussig (page 69); Alice Hamilton (page 70); Elizabeth Blackwell (page 94); Ellen Richards Swallow (page 98).

BOOKS — GENERAL

Ernest, John. MATHEMATICS AND SEX ADULT
Mathematics Department
University of California
Santa Barbara, California 93106

The result of a study on women in mathematics. Despite its provocative title, the booklet is a serious document which explores student attitude and teacher attitude. It makes the case for the need for more mathematical preparation for women in high school and contains a fine list of research references.

Kramer, Edna. THE NATURE AND GROWTH OF MODERN MATHEMATICS ADULT
Fawcett Publications, 1970
(Available in paperback)

Traces the changes, progress, and history of the concepts of contemporary mathematics. It is supplemented by biographical and background material including the contributions of women mathematicians.

Kundsin, Ruth B., editor. WOMEN AND SUCCESS ADULT
Morrow, 1974
(Originally published as SUCCESSFUL WOMEN IN THE SCIENCES)

This book contains a variety of material, including the personal experiences of women scientists, effects of family and education on women, and psychological perspectives on women.

NONPRINT MEDIA

Film

ABOUT RUBBER PR-IN

Distributed by Films Incorporated
1144 Wilmette Ave., Wilmette, IL 60091
11 minutes; rental •17; sales •140; Order #106-0078

A young Malaysian girl narrates a tour of the tropical rubber plantation where her parents work. She takes the viewer through every step of production to the final rubber products.

INTERN: A LONG YEAR JH-SH

Extension Media Center
2223 Shattuck Ave., Berkeley, CA 94720
20 minutes; color; rental •19

Encyclopedia Britannica
425 N. Michigan Ave., Chicago, IL 60611
Sales •225

Dr. Karen Mack is an intern in a poor public hospital in Philadelphia. An excellent portrait of a competent professional handling many aspects of her profession.

KEEP THE DOOR OPEN JH-SH

R.C. Colgan
Motion Picture Division
3153, Sandia Laboratories, Albuquerque, NM 87115
20 minutes; 16mm; color
Available at no cost except return postage

In this film, women who are professional scientists, mathematicians, and engineers discuss their educational and career experiences, and they comment on their attitudes and attitudes of their peers, both while growing up and in the present.

MISS GOODALL AND THE WILD CHIMPANZEES JH-SH-ADULT

Produced by National Geographic Society
Distributed by Films Incorporated
1144 Wilmette Ave., Wilmette, IL 60091
Available in two versions:

Original, 51 minutes; Order #083-0001FI
Rental •35; Sales •330
Edited, 28 minutes; Order #083-016FI
Rental •23; Sales •330

Armed only with binoculars, Goodall won acceptance by the chimpanzees in Tanzania's Gombe Stream Reserve. She logged a unique record of their behavior.
The film is narrated by Orson Welles.
Other films on Goodall are available from the National Geographic Society.

SECRETS OF A BROOK PR

Distributed by Indiana University
Audio-visual Center
Bloomington, Indiana 47401
30 minutes; B&W; rental \$7.25; sales \$150; Order #NS-1197

A poetic view of a young girl of ten as she walks through the woods following a brook from its source in the marsh grass, to the first waterfall, to a small pool. The plant and animal life adds to the child's enjoyment.

THE SILENT SPRING OF RACHEL CARSON SH

Distributed by Contemporary McGraw-Hill Films
Sales Service Dept.
330 West 42nd St., NYC 10036
54 minutes; B&W; rental \$25; sales \$275

An examination of the questions raised by Carson's book THE SILENT SPRING. Are we destroying ourselves with pesticides? Do they upset the balance of nature? Carson gives her view and her critics express theirs as well.

THREE YOUNG AMERICANS IN SEARCH OF SURVIVAL SH

Distributed by Xerox Corporation
245 Long Hill Rd., Middletown, Conn. 06457
18 minutes; rental \$20; sales \$220; Order #27416

Paul Newman narrates this film concerned with survival. Three young people demonstrate how humans are linked with other living organisms. One of these three is Mary Margaret Goodwin, a conservationist and marine environmental student involved in protecting Caribbean waters from pollution.

TUGGER WAR SH-ADULT

EDC Distribution Center
39 Chapel St., Newton, Mass. 02160
29 minutes; 16mm color; rental \$25 (3 days); sales \$350

Documents MIT's mechanical engineering department's Introduction to Design course which ends, each year, with a design contest. The 1976-7 project was the Sandbox Derby, which required each student to build a device called a "Tugger" for the tug-of-war. A woman student wins for the first time in 1977.

WOMAN DOCTOR IN VIETNAM JH-SH-ADULT

Produced by CBS news (Twentieth Century Program)
Distributed by Macmillan Films
34 MacQuesten Parkway S., Mount Vernon, N.Y. 10550
26 minutes; B&W; rental \$10; sales \$150; Order #BS-941

A courageous doctor, Patricia Smith of Seattle, Washington, and her hospital in the interior of Vietnam. Dedication and humanitarianism in the midst of violence and war.

A VISIT FROM SPACE PR

Contemporary / McGraw-Hill
330 West 42nd St., NYC 10036
10 minutes; color; rental \$10; sales \$160

This animated film shows a little girl who meets a schmoo-type character from outer space. Little schmoo is unable to return home. The girl displays cleverness and ingenuity when she designs a mode of space transportation using her kite.

WOMEN IN THE WORLD OF WORK IN-JH-SH

Vocational Films
111 Euclid Ave., Park Ridge, IL 60626
15 minutes; color; rental •17.50; sales •175

Six women discuss their nontraditional jobs, including a test engineer, scientist, housing inspector, and NASA employee.

WOMEN'S WORK: ENGINEERING JH-SH

MIT Center for Advanced Engineering Study
Dept. 4, Room D-234, MIT
Cambridge, Mass. 02139
26 minutes; color; rental (5 day) •30; sales •295

Explores the experiences of being an engineer and a woman from the perspectives of students, faculty, and professionals. Guides for teachers (•1.00) and students (•.50) accompany the film.

Cassette Tapes

WOMEN IN SCIENCE JH-SH

Produced by Dinah Moche'
American Association of Physics Teachers
Publications Dept., AAPT Executive Office
Graduate Physics Bldg., SUNY at Stony Brook
Stony Brook, N.Y. 11794
(•27.50)

Comes in three-ring binder with three cassettes, slides of women scientists interviewed, and short written biographies. It presents six women who have a variety of backgrounds. The women are Virginia Trimble, astronomer; Diana McSherry, biophysicist; Gwendolyn Albert, environmental engineer; Chien-Shiung Wu, nuclear physicist; Betsy Ancker-Johnson, physicist; Carolyn Leach, physiologist.

American Association for the Advancement of Science
Annual Meeting Tapes (listed below)
CEBAR Communications, Inc.
2735 Central St., Evanston, IL 60201

SCIENCE EDUCATION FOR WOMEN SH-ADULT
212-76T, Price •18

Looks at the importance of women's attitudes and career goals and the role of institutions and government in changing or developing attitudes. Also discusses barriers to women.

OPPORTUNITIES FOR WOMEN IN SCIENCE AND ENGINEERING SH-ADULT
211-76T, Price •18

Looks at how scientifically educated women have done and are doing in America for the purpose of providing a way to the future for women in science.

WOMEN IN MATHEMATICS SH-ADULT
282-76T, Price •18

This symposium addresses major questions concerning women's interests, achievements, mathematical ability, education, and career choices.

GREAT WOMEN IN SCIENCE **SH-ADULT**
235-76T, Price $18

This symposium provides a counterpoint of related, but independent, views on great women scientists in an attempt to produce a wholistic view. Some of the great women discussed are Rachel Carson and Annie Jump Cannon.

CAREER INFORMATION — See CAREER GUIDE section of this packet.